Engineering Library

"THE ENGINEER," JUNE 28, 1929.

With METALLURGICAL SUPPLEMENT.

JUL 1 1 1929

The Engineer.

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VOL. CXLVII.—No. 3833] LONDON: FRIDAY EVENING, JUNE 28, 1929 [PRICE { WITH SUPPLEMENT } ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

HEATING.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Tuesday, 16th July, 1929, for ACCELERATED LOW-PRESSURE HOT WATER HEATING at "Livingstone" Telephone Exchange, Norwood, S.E.

Drawings, specification, a copy of the conditions and form of contract, bills of quantities and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to the Commissioners, H.M. Office of Works.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 2335

The Director-General, India Store Department, Belvedere-road, Lambeth, London, S.E. 1, invites TENDERS for :—

SCHEDULE 1.—1262 DISC CENTRES for CARRIAGE AND WAGON WHEELS.
SCHEDULE 2.—1552 STEEL AXLES for CARRIAGES and WAGONS.
SCHEDULE 3.—12 METRE-GAUGE TANK LOCOMOTIVES.

Tenders due as follows :—
Schedules 1 and 2, 9th July, 1929.
Schedule 3, 16th July, 1929.
Forms of Tender available from the above at a fee (which will not be returned) of 5s. for each Schedule. 2378

Air Ministry.
DIRECTORATE OF TECHNICAL DEVELOPMENT.

TEST ASSISTANT REQUIRED to assist in Chemical Analysis of Metals and Alloys. Candidates should have had general training in science, and practical experience of metallurgical analysis.

Salary 50s. to 60s. plus Civil Service bonus per week, according to experience and qualifications; present equivalent remuneration 79s. 5d. to 92s. 7d. per week.

Preference given, other things being equal, to an ex-Service man.

Write (quoting reference No. A. 355), stating age and full particulars of training and experience, to the CHIEF SUPERINTENDENT, Royal Aircraft Establishment, South Farnborough, Hants. 2334

Crown Agents for the COLONIES.
COLONIAL GOVERNMENT APPOINTMENTS.

APPLICATIONS from qualified candidates are INVITED for the following POST :—

M/1581.—ASSISTANT MECHANICAL ENGINEER REQUIRED by the GOVERNMENT of CEYLON for the RAILWAY DEPARTMENT for three years, to Organise and Take Charge of Planning and Progress Section, to Control Manufacturing Processes (through Shop Foremen), in Machine Shops, Foundries and Blacksmith Shop, and to Control Toolroom. Salary £500 a year, rising to £960 a year by annual increments of £30. A higher initial salary than £500 may be paid if warranted by qualifications and experience. Rent allowance if quarters are not available. Free passages and, if married, for wife and children also, not exceeding four persons besides the candidate selected. Candidates, aged 28 to 35, should have served their time as pupils or apprentices in the Locomotive Workshops of one of the principal British Railways, have had suitable drawing-office experience and, during the last two or three years, have been directly engaged on modern system of progress repairs and manufacture in locomotive, carriage and wagon workshops. They should possess an Engineering Degree or Diploma and be fully conversant with modern production methods, be capable of planning all operations and standard layouts for reproducing spare parts for locomotive and rolling stock, must have a working knowledge of heat treatment processes, and be capable of introducing a gauging system based on the B.E.S.A. standards. They should have administrative ability and be capable of taking charge of the Mechanical Engineering Department if and when required.

Apply at once by letter, stating age, whether married or single, and full particulars of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/1581. 2357

Department of Scientific and Industrial Research.

ENGINEER REQUIRED for Fruit Storage Research Station, East Malling, Kent; age not exceeding 40. Candidates should have a good Honours Degree, with good practical and research experience. Other things being equal, preference will be given to ex-Service men. Scale of salary £350-20-£450 plus Civil Service bonus. Initial pay approximately £485. Superannuation provision will be made under the Federated Superannuation Scheme for Universities.—Further particulars and application forms may be obtained from the SECRETARY, Department of Scientific and Industrial Research, 16, Old Queen-street, S.W. 1, to whom the latter should be returned completed not later than July 6th. 2250

Vacancies for Aeronautical Examiners in Aeronautical Inspection Department. Qualifications required: good general and technical education, thorough engineering training with experience in testing aircraft metallic and non-metallic materials and experience in either :—

(A) For Aircraft Examiners :
Construction aircraft components and assembling complete aircraft and testing installation of aero-engines; or

(B) For Engine Examiners :
Manufacture engine components and inspection complete aircraft engines. Knowledge general principles brake testing and measurement of horse-power. Preference ex-Service men.

Annual salary £175-£10-£225 plus Civil Service bonus (present aggregate £259-£322).

Apply, SECRETARY, Air Ministry (I.G.), Kingsway, W.C. 2. 2315

The Engineer

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PUBLIC NOTICES

Assistant Civil Engineers REQUIRED in Civil Engineer-in-Chief's Department, Admiralty, and H.M. Naval Establishments at home and abroad. Candidates must be between the ages of twenty five and thirty years on the 20th July, 1929; those who have served, or are serving, in the Army, Navy or Air Force may deduct from their actual age any time, not exceeding three years, during which they have so served. Candidates must either (A) be Corporate Members of the Institution of Civil Engineers or (B) have passed sections A and B of the Associate Membership Examination of the Institution of Civil Engineers, or taken a Degree recognised by the Institution as exempting therefrom, and have reached such a stage in their professional training that it is possible for them to become Corporate Members within two years.

Those appointed will be on probation for two years, and will not be confirmed unless and until they, being Corporate Members of the Institution of Civil Engineers, have passed this period of probation to the satisfaction of the Admiralty.

Commencing salary £250 per annum, plus Civil Service bonus, which at the current rate amounts to £111 per annum.

Special consideration will be given to candidates who served in H.M. Forces during the War.

No candidate will be accepted for appointment who fails to pass a strict medical examination as to his physical fitness.

Forms of application, &c., can be obtained from the CIVIL ENGINEER-IN-CHIEF, Admiralty, London, S.W. 1, and should be returned, completed, so as to reach that officer not later than 20th July, 1929.

Candidates will be responsible for any expenses which they may incur in attending for interview. 2231

Royal Indian Marine.
APPOINTMENT OF ENGINEER OFFICERS.

The Secretary of State for India proposes shortly to make a number of APPOINTMENTS of ENGINEER SUB-LIEUTENANTS in the Royal Indian Marine. Candidates must be British subjects, between the ages of 21 and 23, and must have served at least five years as apprentice engine fitters in a recognised engineering firm or Government dockyard. Selected candidates will be given three months' training under the Admiralty before proceeding to India.—Further details and forms of application from the SECRETARY, Military Department, India Office, S.W. 1. Applications should be made immediately. 2361

PUBLIC NOTICES

The Government of INDIA REQUIRE the SERVICES of TWO FOREMEN LIGHTHOUSE MECHANICS for service in the districts stretching from Aden and the Persian Gulf to and including the coasts of Burma. Candidates should be about 30 years of age and preferably unmarried. They should have served an apprenticeship with reputable firm of mechanical engineers and have had some years' experience in a Lighthouse Service or in the works of well-known Lighthouse Contractors. A thorough knowledge of the erection of all lighthouse apparatus is essential. Preference will be given to those who, in addition to the above, have a working knowledge of internal combustion engines and a slight knowledge of building construction.

TERMS.—Salary for each post Rs. 500 a month, rising by annual increments of Rs. 20 to Rs. 600 a month. Five years' agreement in first instance. Second-class passages out and home. House allowance. Special Provident Fund. Strict medical examination.

Forms of application and further particulars should be obtained (by request by postcard) from the SECRETARY TO THE HIGH COMMISSIONER FOR INDIA, General Department, 42, Grosvenor-gardens, London, S.W. 1. Last date for receipt of applications 15th July, 1929. 2330

Administrative County of LONDON.

The London County Council will REQUIRE in September, 1929, at the L.C.C. School of Engineering and Navigation, High-street, Poplar, E. 14, a FULL-TIME TEACHER for the MARINE ENGINEERING DEPARTMENT. This Department prepares for Board of Trade Examinations for Engineer Officers in the Mercantile Marine. Candidates must possess an Extra First Class Certificate. Teaching experience desirable.

Scale of salary (according to Burnham Award) £290, rising by annual increments of £14 to £410. For graduates £276 by £15 to £528. Commencing salary according to experience. The first increment accrues after two years' teaching experience.

Apply, EDUCATION OFFICER (T.1a), the County Hall, Westminster Bridge, S.E. 1 (stamped addressed foolscap envelope necessary), for form to be returned by 15th July. Canvassing disqualifies.

MONTAGU H. COX,
2239 Clerk of the London County Council.

PUBLIC NOTICES

Administrative County of LONDON.

The London County Council will REQUIRE in September, 1929, at the L.C.C. School of Engineering and Navigation, High-street, Poplar, E. 14, a VISITING TEACHER of HEAT ENGINES (Tuesday, 7-9.30), who will be mainly responsible for the Laboratory Work of the Heat Engines Class in the Ordinary Grade National Certificate Course. Fee 16s. for an attendance of about three hours.—Apply, EDUCATION OFFICER (T.1a), the County Hall, Westminster Bridge, S.E. 1 (stamped addressed foolscap envelope necessary), for form, to be returned by 15th July. Canvassing disqualifies.

MONTAGU H. COX,
2240 Clerk of the London County Council.

Armstrong College,
NEWCASTLE-UPON-TYNE.
(IN THE UNIVERSITY OF DURHAM.)

COURSES for the PASS DEGREE of B.Sc. and the HONOURS DEGREE of B.Sc. in MECHANICAL, MARINE, CIVIL or ELECTRICAL ENGINEERING, MINING, METALLURGY, or NAVAL ARCHITECTURE. The curricula of the Pass Degree and the Honours Degree normally occupy periods of three and four years respectively, but candidates presenting evidence of sufficient previous training may be allowed to proceed to either Degree after two years' residence.

The engineering laboratories have recently been extended, and all Departments are equipped for advanced tutorial and research work.

Full particulars of the Courses may be had on application to

THE REGISTRAR,
Armstrong College,
1721 Newcastle-upon-Tyne.

Barry Urban District Council.
NEW WATERWORKS.
CONTRACT D.

The above Council invite TENDERS from experienced contractors for the CONSTRUCTION of the ST. LYTHANS to BARRY SECTION of the PIPE LINE, comprising 4914 Yards of 22in. Diameter Cast Iron Pipes, 3652 Yards of 17in. Diameter Steel Pipes, 1976 Yards of 12in. Diameter Cast Iron Pipes, and 500 Yards of Smaller Pipes, in the County of Glamorgan.

Forms of Tender, general conditions, specification, and schedule of quantities may be obtained from Edward Sandeman, M. Inst. C.E., Consulting Engineer to the Council, 15, Victoria-street, Westminster, S.W. 1, upon payment of Five Guineas, which amount will be refunded upon receipt of a bona fide Tender.

The drawings can be seen after Monday, the 1st July, 1929, at the office of the Water Engineer, Broad-street, Barry, Glam., or by appointment at the office of the Consulting Engineer, 15, Victoria-street, Westminster, S.W. 1.

Sealed Tenders, endorsed "Barry U.D.C. Water: Tender for Contract D, St. Lythans to Barry Section of the Pipe Line," are to be delivered to the undersigned by Twelve Noon on Monday, the 15th July, 1929.

The Council do not bind themselves to accept the lowest or any Tender.

T. B. TORDOFF,
Clerk to the Council.

Council Offices,
Barry, Glam.,
26th June, 1929. 2360

NORTHERN INDIA
ENGINEERING DEVELOPMENT.

Many huge projects are completed, others are under construction, and still more are under consideration. When tendering, remember that we have handled, inter alia, all the material for the Lloyd Barrage, the largest irrigation scheme in the world, and that WE HAVE THE EXPERIENCE to enable us to quote you the most favourable terms for CLEARING and DESPATCHING up country any quantity of material to any site required.

For full particulars apply, EASTERN EXPRESS CO., Ltd., Karachi; or to Messrs. FORBES, FORBES, CAMPBELL and CO., Ltd. (Managing Agents), 9, King William-street, London, E.C. 4. P 5899

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PUBLIC NOTICES

Administrative County of LONDON.

ROTHERHITHE TUNNEL—REPAVING OF CARRIAGEWAY.

The London County Council invites TENDERS for the REPAVING with Granite Setts and Wood Blocks of PORTIONS of the CARRIAGEWAY of ROTHERHITHE TUNNEL. The work must be commenced on 7th October, 1929, and completed ready for traffic by not later than 17th November, 1929.

Instructions for Tender, forms of Tender and contract, &c., with a copy of the drawing, may be obtained on application to the Chief Engineer, the Old County Hall, Spring-gardens, S.W. 1, upon payment of £2 by cheque, draft or money order to the order of the London County Council. This amount will be returnable only if the tenderer shall have sent in a bona fide Tender and shall not have withdrawn the same. Full particulars of the work may be obtained on personal application and the contract documents may be inspected before payment of the fee.

Remittances by post should be addressed to the Chief Engineer at the Old County Hall, Spring-gardens, S.W. 1. Personal inquiries at Room 3A, No. 3 Warwick House-street, Cockspur-street, S.W. 1.

The contractor will be bound to observe the provisions of a fair wages clause, the terms of which are set out fully in the instructions for Tender and form of contract and in "The London County Council Gazette."

No Tender received by the Clerk of the Council at the County Hall, Westminster Bridge, S.E. 1, after 4 p.m. on Monday, 15th July, 1929, will be considered.

The Council does not bind itself to accept the lowest or any Tender.

MONTAGU H. COX,
Clerk of the London County Council.
2340

Bombay, Baroda and Central INDIA RAILWAY COMPANY.

The Directors are prepared to receive up to Noon on Friday, 19th July, TENDERS for the SUPPLY of :—

1. AXLES FOR CARRIAGES AND WAGONS.
2. LAMINATED BEARING SPRINGS.
3. STRAIGHT AXLES FOR LOCOMOTIVES AND MOTOR COACHES.
4. STEEL BOILER TUBES, FLUE TUBES AND STEAM PIPES.
5. TYRES FOR LOCOMOTIVES.

And up to 2.30 p.m. on Wednesday, 17th July, TENDERS for the SUPPLY of :—

6. COPPER FIRE-BOX PLATES.

Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 10s. each for Nos. 1 to 5, and 20s. each for No. 6 (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG,
Secretary.

Offices : The White Mansion,
91, Petty France, Westminster, S.W. 1,
26th June, 1929. 2365

Egyptian Government.

TENDERS are INVITED by the Ministry of Public Works for the SUPPLY and ERECTION at Roseill Pumping Station of TWO DIESEL PUMPING UNITS and ACCESSORIES. Tenders are due in Cairo Noon, 10th August, 1929.

Specifications may be obtained from the CHIEF INSPECTING ENGINEER, Egyptian Government, 41, Tothill-street, London, S.W. 1, against payment of £1 0s. 6d., which sum is not returnable. 2356

Holborn Union, London.

TO BUILDERS AND CONTRACTORS.

The Guardians of the Poor of the Holborn Union invite TENDERS from persons willing to contract for the EXTENSION of the TODDLERS' COTTAGE at their Holborn Schools, London-road, Mitcham, Surrey, in accordance with the drawings and specification prepared by their Architect.

The bills of quantities, and form of Tender may be obtained from the undersigned at the Guardians' Offices, 53, Clerkenwell-road, E.C. 1, between June 24th and July 17th, 1929, upon depositing £1, which will be returned upon the receipt of a bona fide Tender. Drawings may be inspected at the Guardians' Offices.

Tenders must be signed, sealed and addressed to the Guardians and delivered at their offices not later than Twelve Noon on the 17th July, 1929, endorsed "Tender for Extension of Toddlers' Cottage," and the same will be opened at a meeting of the Guardians on that day. Each person tendering must be prepared to give satisfactory references and sureties if required. The Guardians do not bind themselves to accept the lowest or any Tender.

No contract will be given to firms who do not ordinarily observe the recognised rates of wages and hours of labour.

CHAS. J. CROSS,
Clerk to the Guardians.

Administrative Offices,
53, Clerkenwell-road, E.C. 1,
19th June, 1929. 2325

Liverpool Corporation Water-WORKS.

VYRNWY AQUEDUCT—THIRD INSTALMENT.
CONTRACT NO. 10.
PIPE LAYING.

The Water Committee of the Liverpool Corporation are prepared to receive TENDERS from competent persons willing to enter into a contract for the LAYING of STEEL PIPES of 42in. internal diameter and other ancillary WORKS, as follows :—

From Cotebrook to Brown Moss, a distance of about 5 2-3rd miles.

The plans and sections may be inspected and copies of the specification and form of Tender obtained at the Water Engineer's Office, 55, Dale-street, Liverpool, upon payment of the sum of Five Guineas, which amount will be returned upon receipt of a bona fide Tender.

Tenders, endorsed "Tender for Pipe Laying," are to be sent through the post in a sealed envelope, addressed to "The Town Clerk, Municipal Buildings, Liverpool," so as to be delivered not later than Twelve o'clock Noon on Friday, 19th July, 1929.

The Water Committee do not bind themselves to accept the lowest or any Tender.

WALTER MOON,
Town Clerk.

Municipal Buildings, Liverpool,
June, 1929. 2371

TO ENGINEERING CONTRACTORS.

The Corporation of Liverpool

invite TENDERS for the ENGINEERING WORK required at proposed Washhouse at Garston Baths.

Plans, specification, and form of Tender may be obtained on application to the Baths Manager, Baths Department, 75, Dale-street, on payment of One Guinea, which will be returned on receipt of a bona fide Tender.

Tenders must be enclosed and sealed up in the official envelope provided, addressed to the Town Clerk, Municipal Buildings, Liverpool, and endorsed "Tender for Engineering," and delivered by letter post not later than 10 a.m. on Wednesday, the 17th July, 1929.

The Corporation do not bind themselves to accept the lowest or any Tender.

WALTER MOON,
Town Clerk.

Liverpool, 27th June, 1929. 2327

Gears
See large advertisement next week.
The Power Plant Co. Ltd.
WEST DRAYTON · MIDDLESEX

PUBLIC NOTICES

South Indian Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for the SUPPLY of:—

1. AXLES FOR CARRIAGES AND WAGONS.
2. STEEL SCREW COUPLINGS.
3. SPARE PARTS FOR CARRIAGES (Yorkshire Iron Draw-bar Hooks).
4. LINOLEUM.

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tender for Axles for Carriages and Wagons," or as the case may be, with the name of the firm tendering, must be left with the undersigned not later than Twelve Noon on Friday, 12th July, 1929.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of 5s. for each copy of Specifications Nos. 1, 2, and 3, and of 2s. 6d. for each copy of the Specification No. 4.

Copies of the drawings may be obtained at the offices of the Company's Consulting Engineers, Messrs. Robert White and Partners, 3, Victoria-street, Westminster, S.W. 1.

A. MUIRHEAD,
Managing Director.

91, Petty France, Westminster, S.W. 1,
26th June, 1929. 2376

The Madras and Southern MAHRATTA RAILWAY COMPANY, Limited,

invite TENDERS for :—

370 TONS (Approx.) STRUCTURAL STEEL WORK for CARRIAGE CONSTRUCTION SHOP (together with Bolts and Nuts, Patent Glazing, Galvd. C.I. Piping, &c. &c.).

Tenders are due in on Thursday, 1st August, 1929, by 10.30 a.m.

Tender form obtainable at Company's office ; fee One Guinea, which is not returnable.

The Directors do not bind themselves to accept the lowest or any Tender.

Company's Office :
25, Buckingham Palace-road,
Westminster, S.W. 1. 2337

West Midlands Joint Electricity AUTHORITY.

IRONBRIDGE POWER STATION.

TENDERS are INVITED by the above-mentioned Authority for STRUCTURAL STEEL WORK required in connection with their Ironbridge Power Station.

The steel work will comprise all that required for the Engine-room, Switch-house, Riverside Pumphouse and also for a Road Bridge across the river Severn, with a span of 160ft. and two flood spans of 55ft. each.

The contract will include the supply, delivery and erection of the whole of the above-mentioned steel work, including the complete erection of the bridge upon abutments to be provided by the Authority.

Copies of Specification (No. 5), drawings and form of Tender may be obtained from Mr. E. F. Hetherington, M.I.E.E., M.I. Mech. E., Chief Engineer and Manager, at the offices of the Authority, on payment of a deposit of Two Guineas, which will, after the Authority have come to a decision upon the Tenders received, be returned to the tenderer, provided he shall have sent in a bona fide Tender and shall not have withdrawn it. Additional copies of the specification may be obtained on payment of One Guinea per copy, which will not be returned.

Tenders must be forwarded under sealed cover, endorsed "Tender for Contract No. 5—Ironbridge Power Station," so as to reach the undersigned not later than Noon on Wednesday, the 18th July, 1929.

The Authority do not bind themselves to accept the lowest or any Tender.

H. F. CARPENTER,
Clerk and Treasurer.

Offices of the Authority :
Phœnix Buildings, Dudley-road,
Wolverhampton, 25th June, 1929. 2333

Borough of Bexhill.

ASSISTANT WATER ENGINEER.

APPLICATIONS are INVITED for the POSITION of ASSISTANT WATER ENGINEER. Candidates must have sound knowledge of Oil and Electric Pumping Plant, Deep Well and Bore-hole Pumps, and the preparation of plans and specifications for the carrying out of all new work required in a water undertaking.

The person appointed will be required to act directly under the Borough Water Engineer.

Preference will be given to applicants who are connected with the Institute of Water Engineers.

Salary to commence at £250 per annum, rising by two equal annual increments to £300.

Applications, endorsed "Assistant Water Engineer," giving full particulars of age, experience and qualifications, together with copies of not more than three recent testimonials, to be received by me not later than Friday, July 12th.

Canvassing, either directly or indirectly, will disqualify.

S. J. TAYLOR,
Town Clerk.

Town Hall, Bexhill,
26th June, 1929. 2366

Borough of Bexhill.

ASSISTANT WATER INSPECTOR.

APPLICATIONS are INVITED for the POSITION of ASSISTANT INSPECTOR in the WATERWORKS DEPARTMENT. Candidates must have experience of the Recovery of Waste, a knowledge of Plumbing, and be able to carry out Repairs and Read and Repair Water Meters. Night inspection will have to be undertaken when necessary.

The person appointed will be required to act directly under the Borough Water Engineer.

Wages £3 per week, rising by two annual increments at the rate of 5s. per week each to £3 10s. per week, subject to satisfactory service.

Applications, endorsed "Water Inspector," giving full particulars of age, qualifications and experience, and accompanied by copies of testimonials, to be addressed to the undersigned so as to be received not later than Friday, July 12th.

Canvassing, either directly or indirectly, will disqualify.

S. J. TAYLOR,
Town Clerk.

Town Hall, Bexhill,
26th June, 1929. 2367

Egyptian Government.

APPOINTMENT OF A MECHANICAL ENGINEER.

APPLICATIONS are INVITED for APPOINTMENT as MECHANICAL ENGINEER in the Ministry of Public Works, Cairo, for work with the Egyptian Irrigation Service in the Sudan.

Applicants must be of British nationality, between 30 and 35 years of age, preferably unmarried, and possess the following qualifications :—

Must have had sea-going and general workshop experience and must produce certificates of satisfactory service, preferably where native labour was employed.

Salary £E24 per month plus forty per cent. Sudan allowance (£E1 equals £1 0s. 6d. approximately), free of Egyptian income tax.

Pay begins on day of reporting for duty in Cairo. Sudan allowance begins on arrival in the Sudan.

Free furnished quarters outside Khartoum provided.

The appointment is subject to medical examination.

The selected candidate will be granted actual expenses of steamer and railway journey to Egypt plus £E10, provided total does not exceed £E40, and similarly on return from Egypt.

Initial period of contract 2 years, subject to renewal.

Third-class fares and reasonable out-of-pocket expenses will be paid to applicants who are requested to attend for interview and/or medical examination.

Application and specimen contract forms may be obtained from :

THE CHIEF INSPECTING ENGINEER,
Egyptian Government,
41, Tothill-street, Westminster, London, S.W. 1,

to whom they should be returned with full particulars as to education, qualifications, previous experience personal references and COPIES of certificates or testimonials.

Envelopes to be inscribed "Mechanical Engineer."
2316

PUBLIC NOTICES

City of Liverpool.

CITY ENGINEER'S DEPARTMENT.
RESIDENT ENGINEER—SEA WALL AND EMBANKMENT SCHEME.

APPLICATIONS are INVITED for the POSITION of RESIDENT ENGINEER under the City Engineer in connection with the above scheme.

The appointment will be a temporary one, lasting about two years.

Applicants must have had considerable experience in the construction of this class of work and should state clearly in their applications the various works of this type carried out under their supervision.

Applications, stating age, experience and qualifications, accompanied by copies of not more than three testimonials, to be forwarded through the post, addressed to the undersigned, endorsed "Resident Engineer," so as to arrive not later than the first post on Tuesday, the 9th July, 1929.

Salary £750 per annum.

The appointment will be subject to one month's notice on either side.

Canvassing, directly or indirectly, will be deemed a disqualification.

WALTER MOON,
Town Clerk.

Municipal Offices,
14th June, 1929. 2286

Metropolitan Water Board.

APPOINTMENT OF TWO JUNIOR ENGINEERING ASSISTANTS.

The Metropolitan Water Board invite APPLICATIONS from those who are students of the Institution of Civil Engineers or have passed an examination qualifying for studentship for the APPOINTMENTS of TWO TEMPORARY JUNIOR ENGINEERING ASSISTANTS in the department of the Chief Engineer, at an inclusive salary of £3 per week.

Applications, in the candidates' own handwriting, stating age and full particulars of training and qualifications, should be addressed to Mr. Henry E. Stilgoe, M. Inst. C.E., the Chief Engineer, and must reach the offices of the Board not later than the 15th July, 1929.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
173, Rosebery-avenue, E.C. 1,
26th June, 1929. 2364

Surrey County Council.

HIGHWAYS AND BRIDGES DEPARTMENT.
APPOINTMENT OF ENGINEERING ASSISTANT.

APPLICATIONS are INVITED for the APPOINTMENT of an ENGINEERING ASSISTANT in Division 2, Class 4, of the Council's Established Staff, at a commencing salary of £345, rising by annual increments of £15 to £450 per annum.

The appointment is subject to the provisions of the Local Government and other Officers' Superannuation Act, 1922, and the successful candidate will be required to pass a medical examination and to contribute 5 per cent. of salary to the Superannuation Fund.

Applicants must have practical experience in the construction and repair of roads and bridges and have a thorough knowledge of the design of bridges in all materials. They must also be competent to make surveys, take levels, and assist in the preparation of specifications and bills of quantities, and preference will be given to candidates who are Associate Members of the Institution of Civil Engineers or who hold the Testamur of the Institution of Municipal and County Engineers.

Forms of application may be obtained from the undersigned, to whom applications on such forms, accompanied by copies of not more than three recent testimonials, must be delivered in sealed envelopes, endorsed "Engineering Assistant," by the 13th July, 1929.

Canvassing, directly or indirectly, will disqualify.

DUDLEY AUKLAND,
Clerk of the Council.

County Hall, Kingston-on-Thames,
25th June, 1929. 2332

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED, a Thoroughly Capable and Experienced HEAD COLLIERY MANAGER and AGENT, for a group of Collieries in the North Midlands. Experience in the Sinking and Layout of a large modern Colliery and the Installation of By-product Coke Oven Plant would be an advantage, and also experience in connection with Coal Leases. The application should state fully any practical knowledge of conveyor working and electrical machinery.—Address, giving experience, dates and particulars of certificates held, 2322, The Engineer Office. 2322 A

WANTED, ASSISTANT SUPERINTENDENT for large works engaged on light mass production. Successful executive experience as well as a good practical knowledge of tools and methods necessary.—Address, 2182, The Engineer Office. 2182 A

AN Experienced DESIGNER for Reciprocating and Direct-acting Pumps, high and low pressure, Well and Bore-hole Pumps ; also an IMPROVER. State age, experience, and salary.—Address, 2218, The Engineer Office. 2218 A

ASSISTANT to PLANT ENGINEER REQUIRED for Large Locomotive Engineering Works in Glasgow area. Must have experience in the design and layout of modern Machine Tools and General Plant. Applicants to state experience in full and wages expected, enclosing copies of testimonials.—Address, "256," Wm. Porteous and Co., Advertising Agents, Glasgow. P5942 A

ASSISTANT WORKS MANAGER, About 35, Experienced in Plating, Loft Work, General Shipbuilding and Repairs. Must be a practical man and used to control of men. London district. State salary and experience, copies of references.—Address, 2336, The Engineer Office. 2336 A

ENGINEER (Certificated) REQUIRED to Manage Shore Plant, age about 30. Commencing salary £250. State education, experience, and qualifications. No testimonials needed.—Address, P5937, The Engineer Office. P5937 A

LEADING WATER SOFTENER MAKERS REQUIRE STEAM ENGINEERS, about 40, as SALESMEN in Home Counties, Midlands, Derby, Leicester, and West Riding. Salary, expenses and commission paid.—Write, stating age, with full particulars, to Box 857, Sells, Fleet-street, E.C. 4. 2338 A

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REQUIRED for Mid. East., ENGINEER, with general exp., knowledge of estimating, drawing-office, oil engines, &c., a recommendation. Age 23/27, single. Passage paid.—Address, with copies of references, P5938, The Engineer Office. P5938 A

TIME STUDY.—MAN with Experience in Fixing Piecework Prices from drawings for Machine Shops. Must be able to draw out own set-ups on combination turret lathes, milling machines, &c. It is essential that applicants be used to Steel Castings of repetition nature for Commercial Vehicles.—Address, giving full particulars of age, experience, and salary required, 2314, The Engineer Office. 2314 A

TO STRUCTURAL AND CIVIL ENGINEERS.—Manufacturers of Building Materials to Architects', Engineers', and Public Authorities' Specifications, and who have large existing London connection, REQUIRE First-class LONDON REPRESENTATIVE. Applicants must have had previous experience with good salary in a similar capacity, and connection, and must be accustomed to settling of large contracts. Age 30 to 40. Knowledge of Structural Details desirable.—Address, with particulars, particulars of connection, experience, references, and salary required, P5926, The Engineer Office. P5926 A

WANTED, a Capable DRAUGHTSMAN, Used to Motor Car Engineering, for detail work. State age, experience, and salary required.—Apply, THE TECHNICAL PRODUCTION ENGINEER, Messrs. Rolls-Royce, Ltd., Nightingale-road, Derby. 2352 A

SITUATIONS OPEN (continued)

WANTED by JOHN HOLROYD and CO., Ltd., Milnrow, a first-class DRAUGHTSMAN, accustomed to designing all types of special Machine Tools. Permanent position and good salary to the right man. Overtime and holidays paid for. 2362 A

WANTED, Experienced and Qualified ENGINEER, with Chemical Engineering experience of Organic Manufacturing Processes. To be responsible for engineering maintenance, electric power and steam generation, planning, design and construction of extensions for new plants. Age about 30/35. State salary expected and particulars of experience.—Address, 2312, The Engineer Office. 2312 A

WANTED by a Large Steel Works, First-rate MAINTENANCE ENGINEER, with thorough experience of large Electrical Equipment, Modern Machine Shop Practice, &c. State age, experience, diplomas, &c. &c.—Address, 2375, The Engineer Office. 2375 A

WANTED for a Gasworks in Kent, a Fully Qualified ELECTRICAL and MECHANICAL FITTER as Leading Hand, to undertake the Maintenance of the Electrical and Mechanical Plant of a Modern Works. Only experienced and steady men should apply. State fully experience and wages required.—Address, 2372, The Engineer Office. 2372 A

WANTED, Experienced MARINE ENGINE DRAUGHTSMEN, accustomed to Machinery and Pipe Arrangements for High-class Vessels ; also good BOILER DRAUGHTSMAN. West Coast district. Good salary and prospects for first-class men.—Address, 2160, The Engineer Office. 2160 A

WANTED for Johannesburg, South Africa, Young single DRAUGHTSMAN for Reinforced Concrete Engineers' Office. Commencing salary about £25 per month. Three years' agreement.—Address, 2347, The Engineer Office. 2347 A

WANTED IMMEDIATELY, First-class MECHANICAL DRAUGHTSMAN, preferably with Conveyor and Structural experience.—Address, 2321, The Engineer Office. 2321 A

WANTED IMMEDIATELY, THREE Good DRAUGHTSMEN, experienced in the design and detailing of Light Structural Steel Work. Only first-class men need apply. State age, experience, and salary required.—MILLIKEN BROTHERS and BLAW KNOX, Limited, Wellington House, Strand, W.C. 2. P5940 A

WANTED, SENIOR DRAUGHTSMAN, for an old-established (British) Firm of Constructional Engineers and Shipbuilders in India. Applicant must have served full apprenticeship in engineering workshops with subsequent technical training at recognised Engineering College or University and obtained B.Sc. or B.E. Degree. In addition to general mechanical engineering, must have had considerable experience in the design of Bridge Structures and preparation of competitive designs for all classes of steel work. Public school man preferred and age under 35. A four years' agreement in the first instance, first-class free passage to India and home again on satisfactory termination of services. Excellent prospects for first-class man.

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DRAUGHTSMAN.—ENGINEERING DRAUGHTSMAN REQUIRED temporarily for Railway Engineer's Office in London ; experience in Permanent Way and Surveying essential.

Address, stating age, experience, and salary required, 2341, The Engineer Office. 2341 A

DRAUGHTSMAN for Structural Steel Work REQUIRED by London Firm, with previous similar experience. Permanency for right men. Full particulars age, salary, experience, &c.—Address, 2263 The Engineer Office. 2263 A

DRAUGHTSMEN, JNR. and SNR., REQD., with experience on Small Electrical Instrument and Apparatus Work. Fares paid for interview.—Write in first instance, stating age, exp., and salary reqd., to EMPLOYMENT DEPT., Standard Telephones and Cables, Ltd., Aerodrome-road, Colindale, N.W. 9. 2319 A

DRAUGHTSMAN REQUIRED in London Office of Firm of Engineers. Draughtsman with knowledge of Conveying and Mechanical Handling Plants. Experienced men only need apply, stating age experience, and salary.—Address, 2208, The Engineer Office. 2208 A

DRAUGHTSMEN REQUIRED, Having Sound knowledge of Engineering Work. Progressive positions open for energetic workers. Give full details of experience and salary.—Address, 2317, The Engineer Office. 2317 A

DRAUGHTSMAN REQUIRED for Works in East Midlands ; must have experience in design of modern Centrifugal Pumps for Gravel, Sand and Sewage.—Address full particulars, 2368, The Engineer Office. 2368 A

DRAUGHTSMAN REQUIRED, Experience Automatic Slot Machines preferred, also experienced COST CLERK.—Address, P5945, The Engineer Office. P5945 A

DRAUGHTSMAN REQUIRED by Firm of Water Filtration Engineers in London district, capable of preparing Layouts of Machinery, Pipe Lines and Plant. Technical experience essential and must be a neat and quick tracer.—Address, 2369, The Engineer Office. 2369 A

DRAUGHTSMAN REQUIRED for Leading Automobile Concern, Coventry district. Give fullest particulars, including experience, age, and salary required.—Address, 2370, The Engineer Office. 2370 A

DRAUGHTSMAN (SENIOR) WANTED for Steam Turbine Details and Design, Midlands district.—Address, with full particulars of training, experience, age, and salary required, 2374, The Engineer Office. 2374 A

EXPERIENCED DRAUGHTSMAN REQUIRED in Midlands for Steam Power Station Layouts. State age, experience, and salary.—Address, 2373, The Engineer Office. 2373 A

For continuation of Small Advertisements see page 4.

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A Seven-Day Journal

Improving the Railways.

ON Thursday of last week Mr. J. H. Thomas, Lord Privy Seal and Minister of Employment, had a two hours' conference at the Treasury with the managers of the four railway groups for the purpose of beginning discussions regarding schemes for the reorganisation or development of the railways which are likely in time to have fruitful results. The managers, it is understood, were desirous of hearing what suggestions Mr. Thomas had to make to them, while Mr. Thomas wanted to know what schemes the managers thought could be put in hand without any great delay, provided financial assistance were available. It is gathered that the managers laid before Mr. Thomas a statement of the obsolete restrictions, which it is held, hamper the operation of the railways, and particularly stressed the restrictions imposed on the raising of fresh capital. Mr. Thomas, for his part, is understood to have favoured the revival of the Trade Facilities Act, and to have suggested that by means of it the railways might carry out schemes for the improvement of rolling stock, port equipment and terminal equipment, for the reconditioning of goods depôts, for dealing with the problem of the privately owned wagon, and for electrification. Under the terms of the last Budget, introduced by the Conservative Government, the railway companies, in return for the remission of the passenger duty, are already under an agreement to expend a sum of about £6,000,000, the capitalised value of that duty, on the improvement of transport facilities.

Deep Diving.

THE effects of submergence in water during the process of deep diving do not merely depend upon the subjection of the diver's body to the hydrostatic pressure incident to the depth to which he descends, but rather to the physiological effects that pressure produces in his internal economy. This fact has long been realised and is emphasised by the recent trials of a new apparatus made by Siebe, Gorman and Co. in the deep waters of Loch Long, when divers conveniently worked at depths of some 300ft.—that is to say, they were subjected to an external pressure of about 133 lb. per square inch. Subsequent to a spell of work at the bottom of the sea, this pressure must be reduced to that of the atmosphere, and if during this process the diver's body is not allowed to accommodate itself to the new conditions in a gradual manner, the man is liable to serious trouble. The new device tested in Loch Long is intended to facilitate this process, to reduce its duration, and to make it more comfortable. Incidental to the trials just mentioned there were some others, which had for their object the escape of men imprisoned in sunken submarines; but as we hope soon to give some technical details of the apparatus concerned in both these developments, we will not enlarge upon them here.

Three Months of the England-India Air Mail.

DURING the first three months of its operation, the Croydon–Karachi air service of Imperial Airways has carried a total of over 12,000 lb. of mails between the two countries. On the twelve outward journeys, the mails carried amounted to about 4700 lb. On an equal number of journeys inwards the weight carried was about 7300 lb. It is curious to learn that whereas the mail from Karachi was 480 lb. on the first despatch and has increased continuously ever since, that from Croydon has fluctuated quite erratically above and below the 318 lb. carried on the first trip. On the third outward voyage the amount carried was only 290 lb., but on the twelfth it was 522 lb. The postage by the air mail is 6d. per half ounce, so that the revenue for the three months has amounted to nearly £10,000. That figure, it is anticipated, will be considerably improved upon in the future. Although the financial success of the service is not as yet assured, the first quarter's results have given the company, it is said, complete satisfaction. By next spring, when the first of some new air liners will become available, it is hoped to reduce the time occupied on the journey from 7½ to 6½ days. Night flying should then be possible on one section of the route between Baghdad and Basra, which is to be lighted by the Air Ministry. Elsewhere, however, there is at present no intention of adopting night flying, although were it possible to resort to it, it would probably be possible to perform the journey in 5½ days. The principal need of the service at the present moment is an extension of it from Karachi to other centres in India, in order to cut out the delays experienced on the Indian railways.

Drought Defences.

IT seems appropriate, and topical, at a time when we in London are being warned that water is becoming scarce, that we should receive news of three provincial schemes for conserving potable water. In London, of course, there is little liability of an absolute shortage, as the Metropolis is adequately served by the great reservoirs which have already been completed and filled; but we have listened to tales of jealousy in this connection in counties which have not been so provident. Anyhow, the districts of Barnsley, Manchester and Stockport are making good provision against future requirements. Thus the new Scout Dyke reservoir at Barnsley was formally opened on the 20th inst., while schemes for increasing the water supplies for the other two towns were almost simultaneously decided upon. The Manchester proposal is to form two new reservoirs in the valley of Mardale and Swindale, which will involve the submergence of the church at Mardale—Philæ repeated—while the Stockport scheme will completely change the landscape in Goyt Valley near Buxton. The proposal is to construct two reservoirs, stretching for a distance of about 2 miles down the river, which would have a capacity of 800 million gallons. The works would involve the demolition of old Goyt Bridge and the surrounding hamlet.

German Liner "Bremen" at Southampton.

As the large dock at Hamburg—the only one in Germany capable of taking very heavy ships—is occupied at present by the "Europa," the 46,000-ton North German Lloyd liner which was seriously damaged by fire last March, her sister ship, "Bremen" is to be docked at Southampton for the final survey of her hull before being delivered to the owners. According to present arrangements, the "Bremen," will arrive on Monday next, July 1st, at a very early hour, and will be placed as soon as possible in the great floating dock belonging to the Southern Railway Company, which has a lifting capacity of 60,000 tons. It is anticipated that the survey will be completed in two days, after which the ship will return to Bremen to be made ready for her maiden voyage across the Atlantic, beginning on July 16th. It is no secret that her owners expect this vessel to establish a new speed record on the Southampton-New York route. She was laid down in the Weser Shipyard on June 18th, 1927, and was launched on August 16th of the following year, but her completion was delayed by the prolonged shipyard strike in Germany which began last autumn. She has a length of 933ft. overall, a beam of 100ft., and is propelled by quadruple-screw, single-reduction, geared turbine machinery of 96,000 S.H.P., taking steam from oil-fired boilers. The contract speed is 26½ knots, which will probably be improved upon when the engines have been "run in." The design of this ship and her consort has been enveloped in a certain amount of mystery up to now, but the North German Lloyd announces that complete details will be released as soon as the "Bremen" has begun her maiden voyage. Her cost is officially stated to be £2,600,000.

Railways and Road Traffic.

THE railway companies continue to make efforts to put into effect the powers which they recently acquired to own or operate road transport services on an extended scale. The direction in which these efforts are proceeding is, in the main, the union of the companies' interests with those of established road transport undertakings, rather than the institution by the railways of new road services under their own control and ownership. It is reported on good authority that the Southern Railway is engaged in discussing with the London General Omnibus Company a scheme for the joint control of road transport in the southern sections of the metropolitan area. Last week a meeting was held in Glasgow between representatives of the London, Midland and Scottish and the London and North-Eastern railways and of the Glasgow Corporation Tramways Committee for the purpose of discussing a scheme for the joint ownership and control of road transport in Glasgow and the West of Scotland. It would appear that the companies are seeking to secure an agreement similar to that which is now in force between them and the Corporation of Sheffield, under which the omnibus routes within the city are operated by the Corporation, the medium distance routes jointly, and the long-distance routes by the railway companies. The companies' proposals in the case of the Glasgow area were, it is stated, not such as the Tramways Committee was prepared to accept. The meeting was adjourned for a fortnight to allow each side farther to consider the question.

The Ironbridge Power Plant.

THE West Midlands Joint Electricity Authority has just given an order to the British Thomson-Houston Company, Ltd., of Rugby, for the first unit of equipment for the Ironbridge super-power station on the river Severn, to which we have previously referred. The principal item is a 50,000-kW two-cylinder double-flow steam turbine coupled to a three-phase, 11,000-volt, 80 per cent. power factor, 50-cycle alternator. The alternator will be equipped with the closed system of air cooling. The steam pressure for the turbine will be 375 lb. per square inch and the temperature 750 deg. Fah. The condensing plant, by Hick, Hargreaves and Co., Ltd., of Bolton, will be supplied with circulating water from a separate pump-house on the river bank equipped by Drysdale and Co., Ltd. Included in the contract there are three 21,000-kVA B.T.H. single-phase, oil-immersed, self-cooled, outdoor type transformers giving 33,000 volts between the phases. They are connected in delta on the primary side and in star on the secondary. These transformers are said to be the largest of their kind ordered in this country. All switching is to be effected on the 33,000-volt circuit by means of electrically operated switchgear of the remote electrically operated, duplicate bus-bar, oil-insulated, vertical plugging, metal-clad type. This gear is to be fitted with oil circuit breakers having a rupturing capacity of 1,500,000 kVA. The 62,500-kVA generator equipment and the two 75,000-kVA grid transformer equipments will be provided with duplicate circuit breakers, and the two group feed equipments are to have single breakers. In addition, there are to be two sets of group feeder reactors. Auxiliary 33,000-volt switchgear for two distribution feeders, two standby feeders, and two works supply feeders, together with a bus coupler and two group feeder isolating equipments, are also included in the order. This switchgear will be of the duplicate bus-bar, compound-filled, horizontal plugging, metal-clad type arranged for remote electrical operation. The oil circuit breakers will have a rupturing capacity of 500,000 kVA at 33,000 volts.

The Pinkston Power Station.

FURTHER to the note on this page in our last issue, we have to record that the Glasgow Corporation Tramways Committee has now approved of the scheme for reconditioning Pinkston power station, as submitted to it by its sub-committee on Works and Stores. As we have already stated the Corporation desired to expend a sum of £237,000, of which two-thirds was to be spent on reconditioning the existing plant and one-third on the purchase and installation of a new 18,750-kilowatt turbo-alternator to meet the growing needs of the Tramway Department's demand on Pinkston station. After holding a local inquiry on the subject, the Electricity Commissioners refused to sanction the scheme so far as it related to the installation of a new turbo-alternator, on the ground that any additional power should be obtained from the Corporation's Dalmarnock station or some other source. The Tramways Committee has now abandoned that scheme in view of the Commissioners' opposition to it, and has concentrated on one which, being a scheme entirely of replacement, does not require the Commissioners' sanction. The estimated expenditure on the scheme now proposed is £218,500. Included in that sum are items of £8500 for foundations, piping, and alterations of buildings, and £10,000 for contingencies. The work which it is proposed to carry out includes the installation of six new boilers to replace fourteen of the existing twenty-two boilers which were brought into service in 1901 when the maximum load on the station was 9000 kW, as compared with a maximum of 23,600 kW at the present moment. The scheme also covers the provision of new switchgear to replace the present switchgear, which was installed in 1907, and which was not designed to carry loads such as it is at present called upon to bear. In the third place, the scheme covers the purchase and installation of a new 10,000-kW turbo-alternator to replace two of the existing turbo-alternators which are stated to be inefficient, and which, together with two direct-current generators, are to be scrapped. The capacity of the new set will be similar to the total capacity of the four machines to be discarded.

Improving Conditions.

THE improvements which have recently been shown by the iron and steel trades of the country were reflected in the speech which Sir John Beale, Chairman and Managing Director, delivered at the annual meeting of Guest, Keen and Nettlefolds, Ltd., on Wednesday last. Sir John, after alluding to the several years of difficult trading conditions, said that this year the difficulties had the appearance of becoming less in many directions. In the autumn manufacturers would derive benefit from the very wise measure of derating introduced by the late Government. He believed that derating would not only help his company directly, but would benefit the whole country and would give a real stimulus to trade. "In short," he said, "if no political difficulties arise, I look forward with confidence to a period of increasing prosperity throughout our great organisations." One subject which Sir John touched upon in detail is that of the steel sleeper known as the "G.K.N.," which was fully described and illustrated in our issue of April 12th last. He mentioned the tests, also recorded in our columns, which are being made by some of the great railways of the United Kingdom, which were being impelled to use steel by the increasing difficulty in obtaining thoroughly suitable wooden sleepers at a reasonable price. He hoped that the movement for the increased use of steel in many new directions would continue. As a result of propaganda, many articles formerly made of wood were now made of steel in the United States, and he saw indications of a similar movement in Europe.

The Cascade Tunnel: Great Northern Railway, U.S.A.

No. III. (*conclusion*).*

IN the construction work on this tunnel the contractor's force reached a maximum of about 1800 men, including the three camps. The largest concentration was at the west end, with about 770 men, exclusive of the headquarters force, which was established at this point. Great care was taken to ensure safety, the men being instructed to be careful for themselves and their fellows, and careless or indifferent workmen were soon weeded out. All working operations and equipment were under the supervision of a "safety inspector." At each of the three camps were hospital facilities, in charge of a resident doctor. Frequent tests of the air were made to ensure ample ventilation, and the rock roof was coated with cement grout to prevent spalling.

The total excavation amounted to 934,000 cubic yards, of which the pioneer tunnel represented about 10 per cent. For the lining a total of about 262,600 cubic yards of concrete was required.

Tunnel Section.—In its finished condition the tunnel has a clear width of 16ft. and a height of 22ft. 10in. from the rock floor to the crown of the arch, or 20ft. 10in. above the tops of the rails. In the interior view of the concrete lined tunnel, near the portal, Fig. 18, the cross timbers are to carry the temporary overhead trolley wires for the double track construction railway. The recesses in the roof are for placing the supports for the permanent trolley lines. A detail of the cross section is given in Fig. 19.

Supports for the overhead trolley wires are embedded in the roof at intervals of 75ft. The roof radius is 8ft. 10in. for the central portion and then 6ft. down to the springing line. Numerous electric conduits are embedded in the side walls, with cast iron pull boxes about 600ft. apart to give access to the wires and cables. Most of these conduits, 3in. and 4in. in diameter, are of vulcanised fibre, but those for the telegraph and telephone wires are of galvanised iron, so as to provide a magnetic protection against induction interference from the power lines. On each side of the tunnel are recesses for electric lights and the automatic signal lamps, the latter spaced at intervals of 4800ft. Drainage is provided for by 4in. clay pipes embedded in the side walls as weep holes and discharging into the ditches along the walls.

Refuge chambers are spaced 2400ft. apart on each side of the tunnel, but staggered in position. Those

FIG. 18—INTERIOR OF CONCRETE-LINED TUNNEL

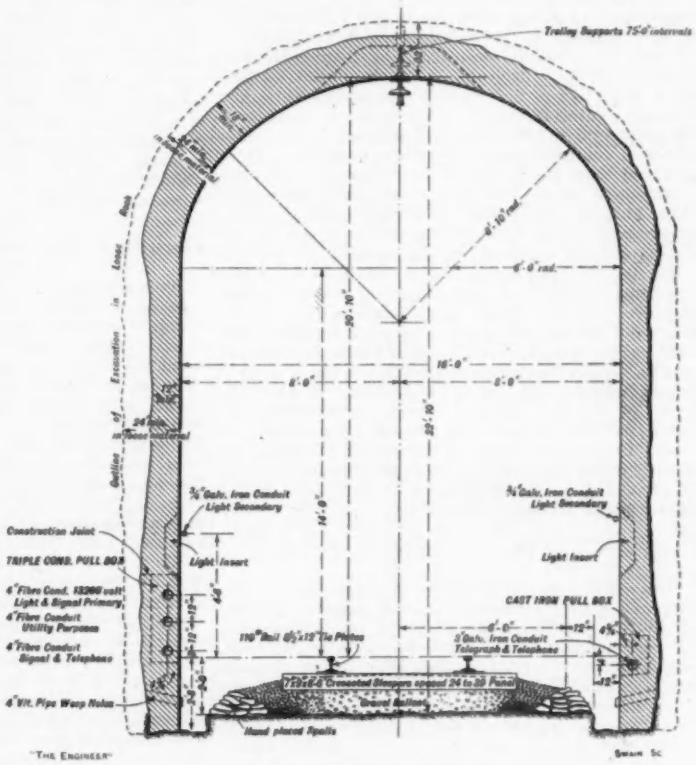


FIG. 19—CROSS SECTION OF TUNNEL.

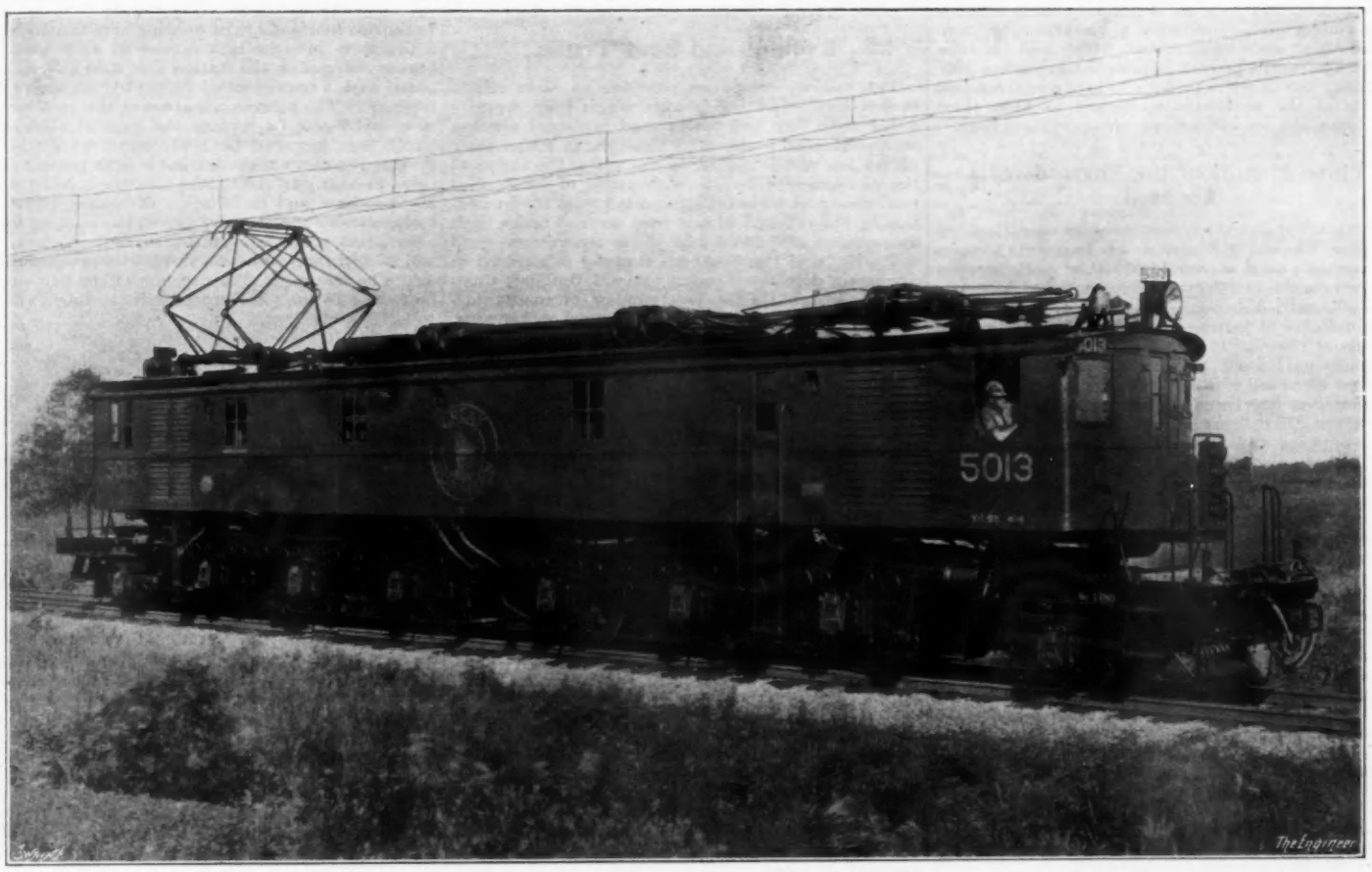


FIG. 20—GENERAL ELECTRIC SINGLE-UNIT LOCOMOTIVE

* No. II. appeared June 21st.

on the north side are for transformers and electrical apparatus, and are 4½ft. wide and 9½ft. long. Those on the south side are 8ft. by 8ft., large enough for a platelayer's lorry, a pair of heavy timbers being placed to support the wheels. For convenience of handling these cars planks are laid on the sleepers and across the ballast to the refuge chamber. Permanent way construction consists of 110 lb. flange rails 39ft. long, with steel base-plates 8½in. by 12in. on sleepers of creosoted fir timber, 7in. by 9in. and 8½ft. long, with twenty-four sleepers to a rail length of 39ft. The ballast is of washed and screened gravel, retained by dry walls of large stones to prevent the ballast from working over into the side ditches.

Reconstruction of East Approach.—As an important auxiliary to the new tunnel, the approach line on the eastern slope has been rebuilt on an entirely new location for about 20 miles. This work eliminated 1286 deg. of curvature and the sharpest radius of curves is now 1910ft., instead of the 636ft. on the old line. The maximum gradient on the new line is 1 in 62 instead of 1 in 45 as on the original location, though there is still a short stretch of 1 in 45 on this approach between the new portion and the tunnel.

Electric Operation.—It has been stated already that the tunnel will be operated entirely by electric locomotives, for, in connection with the new line, the Great Northern Railway has electrified a stretch of 73 miles for convenient and economic working of the entire line across the Cascade Range. When the first tunnel was opened, in 1900, the traffic was worked by steam locomotives, but with increasing traffic, heavier trains and larger locomotives, the conditions became objectionable and dangerous on account of the smoke and gas in this 2¾-mile tunnel.

Electric working was therefore decided upon, and was put in service in 1909. At that time 115-ton electric locomotives took the trains through the tunnel with the steam locomotives coupled on, except that the banking engines used on the heavy gradients of the approaches were detached. Considerable time was lost in this coupling, uncoupling and shunting at the tunnel. This electrification was notable for the adoption of the three-phase 6600-volt system, with two trolley wires and the rails as the third conductor. Current at 33,000 volts was taken from a transmission line and stepped down to 6600 volts for the trolley wire. The locomotives, with three-phase induction motors, had two speeds—15 miles per hour for passenger trains and 7½ miles per hour for goods trains. This was the only important use of the three-phase system on American railways, and the engines were the first American locomotives to utilise the principle of regenerative braking.

In connection with the improvement of the crossing of the Cascades, it was considered advisable in 1925 to extend electric working on the ruling gradient against east-bound traffic on the west slope, and to employ electric banking engines on that gradient. This stretch of electrification, put in operation in March, 1927, extended from Skykomish to the east end of the old tunnel, about 24 miles. A little later, when the approach on the east slope was rebuilt, with more favourable gradients, as described later, it was decided to adopt electric working for the entire distance from Skykomish on the west to Wenatchee on the east side, a distance of 73 miles. Goods trains now weigh about 3500 tons and passenger trains 1000 tons. During the winter, a train-heating tender is coupled between the electric locomotive and the passenger train to serve the steam-heating system in the cars.

For this new electrification, however, the three-phase system was not adopted, partly on account of the complication of the double-trolley equipment, and partly on account of the fact that this system imposes a constant-speed condition. After much study by the consulting engineers, the firm of Jackson and Moreland, a single-phase, 11,000-volt, 25-cycle, trolley-wire system was adopted, in combination with alternating-current–direct-current locomotives of the motor generator type. By this system, the 11,000-volt alternating current taken from the trolley wire is first transformed to 2300 volts and then passed to a motor generator set which delivers 1500-volt direct current to the driving motors. Thus, the system combines the advantages of high-voltage alternating current for long-distance transmission, and the simplicity of the direct-current driving motor, while it eliminates the necessity of establishing sub-stations along the line to convert the alternating current of the transmission system to direct current for delivery to the trolley wire.

Power is purchased from companies having hydro-electric plants on both sides of the mountains. Among other advantages, this arrangement of purchased power provides an adequate power load for absorbing the power produced during regenerative braking at times when the power demand of the railway is not sufficient to absorb this load. For this excess or returned power the railway is credited by the electric company. If the railway had its own independent generating plant, it would be necessary to provide a complicated equipment of rheostats to absorb the excess regenerated power under such conditions.

Current at 44 kV is delivered to seven distributing stations spaced about 10 miles apart, and it is there converted to 11,000 volts for delivery to the overhead trolley wire system. The contact wire is of cadmium bronze, suspended by non-ferrous hangers from a catenary or messenger cable having a bronze core wound with copper strands. On straight track, the poles are 180ft. apart, or 150ft. where they also carry the transmission lines. In the tunnel the roof supports for the wires are 75ft. apart. The normal height of the trolley wire above the rails is 24ft., but that height is reduced to about 20ft. in the tunnel.

Locomotives of two types are used. First, double-unit engines built by the Westinghouse Electric and Manufacturing Co., and, secondly, single-unit engines built by the General Electric Company. The Westinghouse design—Fig. 21—consists of two self-contained separate engines, coupled together both mechanically and electrically, so as to be operated as one large engine. Each unit has four driving axles and single leading and trailing axles, so that the wheel arrangement of the double-unit is 2–8–2–2–8–2. The General Electric single-unit locomotive—Fig. 20—has six driving axles grouped in two driving bogies, with single leading and trailing axles, so that the wheel arrangement is 2–6–6–2. All the locomotives are of the geared motor type, and their principal dimensions are given on page 700.

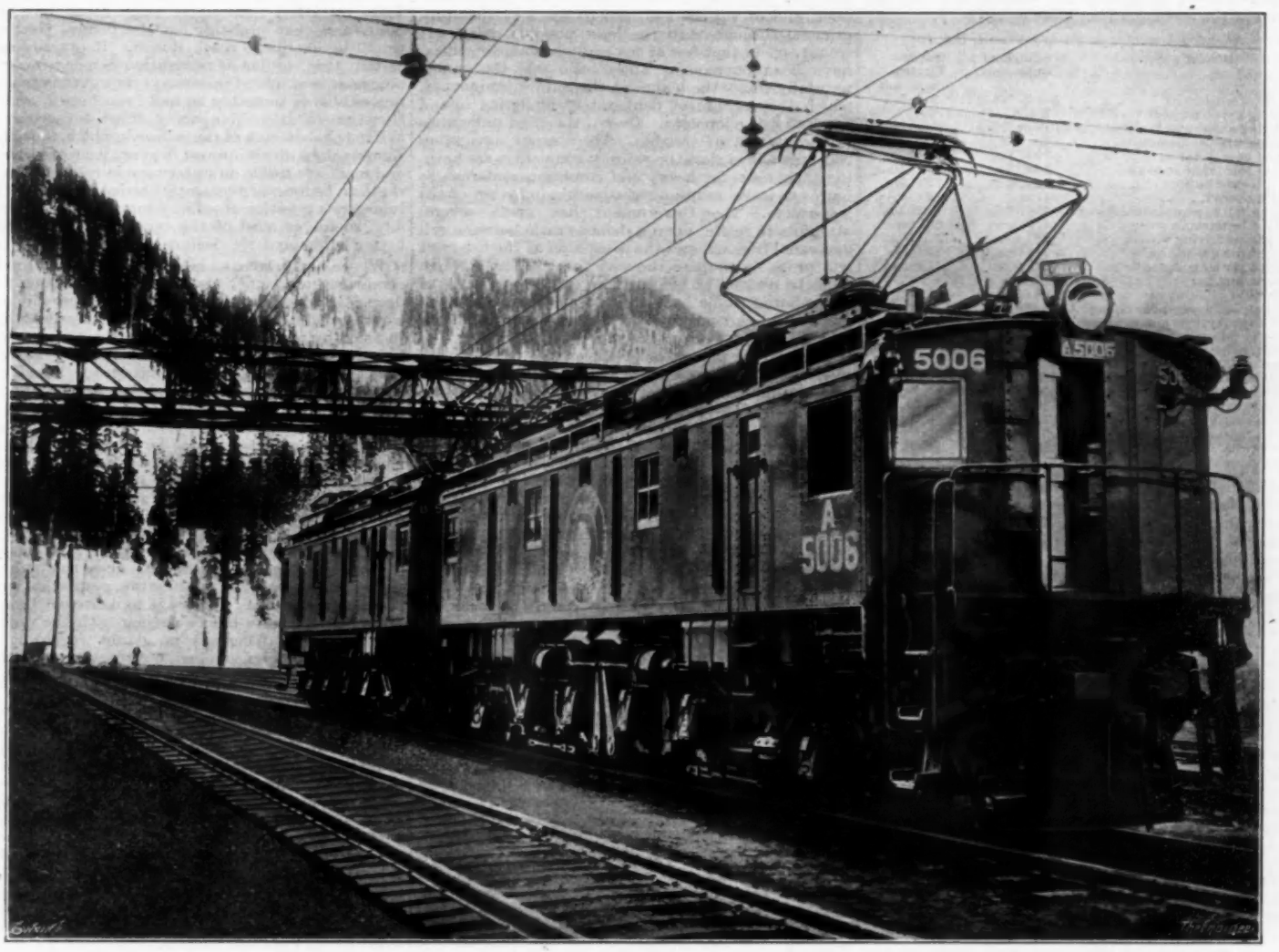


FIG. 21—WESTINGHOUSE DOUBLE-UNIT LOCOMOTIVE

In the single-unit, or General Electric design, the main frame or underframe, 63ft. long, consists of two sills or sole plates of I section, with cross struts and the bogie bolster beams between them, and stiffened by steel plating riveted across the top and bottom for the entire length, so as to form a box section for the floor. An operating cab is provided at each end. This frame is mounted on the pivots or centre plates of two six-wheel driving bogies, the frames of which are connected by an articulated coupling, while the outer end of each frame is extended and carried by a two-wheel guiding bogie of the radius-bar type. The driving bogies are large steel castings, and, with their articulated coupling, take all the stresses due to traction and buffing.

Air-operated pantagraphs carry bronze plates for sliding contact with the trolley wire. Current at 11,000 volts taken from this wire is transformed to 2300 volts for a 2300-volt synchronous motor, which drives two direct-current generators, which are connected in series and supply current at 1500 volts

to the driving motors. The transformers are air-cooled by means of motor-driven blowers.

The motor generator set has its elements mounted on two shafts which are connected in tandem by a flexible coupling. There is first the synchronous motor operating at 2300 volts. Next, is a 65-volt direct-current exciter to supply the control current, excitation of the main generators and the regenerative braking exciter and also to supply the current for charging the storage batteries. Then there are the two 750-volt generators, connected in series and supplying current to three groups of driving motors, each group consisting of two motors connected in series. Finally, there is a combined starting motor and regenerative exciter that is used either as a single-phase series motor to start the motor generator set, or as a direct-current generator to excite the fields of the driving motors during regeneration.

Forged steel pinions on the armature shaft drive cushioned gear wheels on the axles. These gear wheels consist of a forged steel toothed rim and a cast steel centre, the two parts connected by numerous leaf springs which allow for a slight movement between the two parts, in order to cushion the stresses or shocks.

Comparative particulars of these two types of locomotive—Westinghouse and General Electric—are given in the accompanying table :—

Electric Locomotives for Cascade Tunnel, U.S.A.

Builder's system.	Westinghouse, Double unit.	General Electric, Single unit.
Wheel arrangement	2–8–2–2–8–2	2–6–6–2
Driving axles, number	Eight	Six
Carrying axles, number	Four	Two
Driving wheels, diameter	4ft. 8in.	4ft. 7in.
Wheel base, total	78ft. 10in.	58ft. 8in.
Wheel base, rigid, two sets	16ft. 9in.	15ft. 4in.
Length over buffers	94ft. 6in.	73ft. 9in.
Width overall	11ft.	11ft. 0½in.
Height, rail to pantagraph, lowered	15ft. 10in.	15ft. 3in.
Weight in working order	370 tons	264 tons
Weight on driving wheels	285 tons	210 tons
Weight per driving axle	35½ tons	35 tons
Weight per carrying axle	21½ tons	27 tons
Motors, number	Eight	Six
Gear ratio	18 : 91	21 : 82
H.P. capacity, one-hour rating	4330	3300
H.P. capacity, continuous rating	4000	3000
Tractive effort, starting, 25 per cent. adhesion	142,000 lb.	—
Tractive effort, maximum starting, 33½ per cent. adhesion	189,000 lb.	126,600 lb.
Tractive effort, hourly rating	112,500 lb.	67,200 lb.
Tractive effort, continuous rating	88,500 lb.	60,500 lb.
Speed, hourly rating, miles per hour	14·4	18·2
Speed, continuous rating, miles per hour	15·5	18·6
Speed, maximum, miles per hour	45·0	45·0

Although winter temperatures in the Cascades region drop considerably below zero, the temperature within the tunnel—and at only a short distance from the portals—is found to range only between about 55 deg. to 60 deg. Fah. This condition caused some unexpected engine troubles at first. With the large volume of air drawn in by the blowers for the air-cooled transformers and driving motors, frozen moisture would build up on the metal surfaces while the engine was working on the open line, and would then melt in the moist and comparatively warm atmosphere of the tunnel. The entire interior of the engine would become dripping wet, causing trouble with the electrical equipment. This condition was partly relieved at first by shutting off the blowers for the motors, while the engine was in the tunnel, and finally eliminated by providing for recirculation of the air from the transformer blowers through the interior, thus maintaining an interior temperature of about 45 deg. Fah., even with atmospheric temperature below zero. This plan has practically prevented the collection of moisture.

Future Cascade Tunnels.—It is of interest to note that other—though as yet indefinite—projects are in view for tunnelling the Cascade Range. On account of the enormous development of motor-operated vehicle transport for passengers and goods on the public highways, together with the ever-increasing growth of traffic movements to and from the Pacific Coast, there has been developed a project of unexampled boldness for a highway across the Cascade Range at such a low elevation as to be free from snow troubles, and to be practicable all through the year. This would involve a tunnel of great length, varying on proposed routes at different elevations from a minimum of 16 miles to a maximum of 68 miles. In 1927 a Commission appointed to consider the scheme recommended a 30-mile tunnel at an elevation of about 1000ft. It was to be a twin tunnel for both highway and railway traffic, and with approach gradients not exceeding 1 in 100. As yet, this project is only in the paper or promotion stage, but it is quite possible that in a few years it may reach the practical or construction stage.

In the very deep waters of Loch Long, Dumbartonshire, the Admiralty has, according to *The Times*, concluded important and successful tests of two new diving appliances. One is a device enabling submarine crews to escape in emergency to the surface, while the other has materially increased the depth at which it is possible for a diver to work in flexible diving dress. The greatest depth to which naval divers had hitherto descended is believed to be 204ft. With the new apparatus they have reached a depth of 300ft. in Loch Long, and it is claimed that a new world's record has thus been established.

Water Problems in France.

In carrying out their programme of inland waterway and hydraulic development the French aim at reducing manufacturing costs and cheapening goods so that they will be in a better position to compete for foreign trade. They hope that water transport will bring down freights, and that hydraulic power will provide cheaper energy, while a rational utilisation of the water resources will facilitate the problems of water supply and irrigation. All these matters, and some others, are so entirely dependent on each other that they have to be discussed when dealing with the general plan of inland waterway development and they were fully covered at the Congress on Inland Waterways which was organised in Paris last week by the Ligue Générale pour l'Aménagement et l'Utilisation des Eaux. Although so much importance is attached to an efficient utilisation of the extensive waterway system it was quite evident from the papers presented and the discussions that followed that, despite the clear and elaborate programme for improving navigation facilities on rivers and canals, the progress that has been made is much less than what had been expected in view of the efforts of the Government and of various associations to carry that programme through with the least possible delay. It would appear that few of the really serious difficulties have been overcome. Those who use the canals naturally throw the blame on the railway companies, which they accuse of deliberately hindering inland waterway development. One of the chief difficulties is the system of freights. The canal navigation concerns affirm that the railway companies are keeping their rates for heavy and cumbrous materials so low as to leave an insufficient margin in favour of the waterways. The Government has made several attempts to settle upon a definite ratio between rail and canal freights, and the discussion at the Congress will probably prepare the way for a solution which must be arrived at before there can be any hope of water-borne traffic increasing to an extent that will justify the carrying out of the vast programme of inland waterway improvements.

The several papers on canals and waterways all referred to the necessity of executing costly works. The expenditure involved is so enormous that there seems to be little hope of the programme being completed within a reasonable time without the aid of German reparations, and those, as the President remarked, appear to be much reduced by the proposed new arrangement between the creditor countries and Germany. On most of the canals the installations are old, and, incidentally, it was stated that the Briare Canal, begun in 1604 and terminated in 1642, is the oldest in Europe. Much, of course, has been done on some of the canals in the Nord and in the north-eastern departments, but those serving the Paris district have too many barrages, and the locks are not big enough to facilitate the passage of the boats now employed.

It has not yet been definitely decided what power will be used for the navigation. The official preference is for electrification, and that is being followed in the Nord, but elsewhere there is an increasing use of motor barges hauling two or three boats, and some Chambers of Commerce are protesting against the electrified system which the State is endeavouring to impose. The electrification of locks is giving good results, but the Congress, in accordance with a report upon the canalised river Yonne, recommended that one half of the existing barrages should be suppressed. If the traffic on canals is to develop there must be a sufficient number of "ports" equipped with the necessary elevating machinery. On most canals the "ports" are insufficient in number, and very few have any equipment at all. The State is parsimonious, and the communes will not provide the money. The programme for the creation of an economical and efficient network of railways is, therefore, far from being realised because it is costly, and, except for some canals of special and even national importance, the money available for the purpose is totally inadequate.

The inland waterways depend upon a special traffic which may be largely increased by providing the necessary facilities, or it may fall away through unexpected causes. This was suggested by Monsieur Carivenc, general inspector of navigations, who said that it was impossible to say with any degree of certainty what would happen to the waterway system around Paris within the next ten years. The weight of goods carried to and from the port of Paris is about 13,000,000 tons a year, while the traffic dealt with by the railways in the Paris district is 21,000,000 tons and by motor vehicles 3,000,000 tons. It is essentially a one-way traffic, the boats and trains leaving the city with little freight. The total freight carried on all the rivers and canals in 1927 was 37,500,000 tons. The goods arriving in Paris by water comprise sand, gravel and other building material, coal from the northern collieries, timber and other materials of large bulk, but Monsieur Carivenc asked what would happen to the traffic when the gravel pits in the Seine Valley were exhausted, as seems likely to happen at an early date; when the hydro-electric power stations at Eguzon, Genissiat, and those to be constructed along the Rhone sent millions of kilowatts to Paris, and when, as is quite possible, the northern collieries supplied gas to Paris instead of coal? Each system of waterway has its own problems to face, and Monsieur Teste, in a communication upon the port of Havre, stated that the Tancarville Canal had not helped the port in the least. In 1910 the traffic by the Seine between Havre and Rouen was nearly the same as that by rail, but, for years past, the disparity between the two has been growing, until now the bulk of the goods are carried by the railway companies. This decline of water-borne traffic has taken place despite the fact that heavy merchandise can be sent to Paris by water in almost the same time as by goods train. The trouble lies in the time lost in loading boats in a port where sea-going ships have a preference over barges and in the high pilotage fees. It is possible that this trouble may be overcome, for at Havre a dock is being constructed specially for inland waterway boats, and it is reported that arrangements have been come to whereby the Seine navigation companies will obtain satisfaction over the question of pilotage fees. Another point illustrating the difficulty of settling upon a definite policy of inland waterway development is indicated by the rivalry of Rouen, which has carried out considerable works to enable cargo boats to proceed to Rouen instead of unloading at Havre. Monsieur Teste remarked that bigger cargo boats were being built, and that probably, in the future, the boats would be unable to reach Rouen. It appears fairly certain that, so far as navigation is concerned, the programme of inland waterways improvements is not proceeding so smoothly as had been hoped, and the Government is making every effort to secure the active collaboration of the railways, which, it declares, should take a direct interest in every form of transport and facilitate traffic on waterways in respect of goods that can be most conveniently carried by water. This is largely a question of railway rates, but more especially, so far as most of the canals are concerned, of better equipment for dealing with the traffic.

Where canals have to be improved to meet modern conditions of traffic, and where rivers have to be deepened and barrages constructed to provide sufficient draught, the prospect of the enterprise being justified by the traffic alone is not always reassuring. For that reason every scheme of inland waterways that involves a considerable expense is based upon the immediate financial return that can be provided by the supply of electrical energy. Even on the Seine between Paris and Rouen, where the difference of level is small, the scheme for canalising the river comprises eventually a reduction in the number of barrages, whereby four small power plants can be put down to provide a total of something like 56,000 horse-power. The Alsace Canal, with its seven power stations, the first of which will be the one on the Kembs section now under construction, is an example of the dependence of a waterway upon the hydraulic power it can provide. In carrying out the Rhone canalisation scheme, the idea is to construct barrages and power stations before dealing with the problem of navigation. There is no doubt regarding the energy that can be supplied, but there is considerable difference of opinion as to whether it is better to canalise the river or to construct lateral canals. To a large extent, therefore, the success of inland waterways depends upon the energy that can be recuperated, for without that it is doubtful whether any capital could be obtained for constructing canals or rendering rivers suitable for navigation. Hydro-electric energy, from whatever source it is obtained, is a definite national asset, and the question of navigation forms part of a general programme the successful execution of which depends upon a number of factors affecting the economy of water-borne traffic. No doubt the difficulties will be solved in time, but it seems clear that, while the inland waterway traffic is considerable, the work of developing that traffic in competition with the railways will be slow.

Another problem which is causing some anxiety is the provision of an adequate supply of water to Paris. This was the subject of a communication by Monsieur Sentenac, Inspecteur-Général des Eaux et de l'Assainissement, who pointed to the necessity of providing for the rapidly increasing needs of a city which is expanding enormously with the absorption of a large suburban region. In 1928 Paris consumed 483,000,000 cubic metres of water, or an average of 1,300,000 cubic metres a day. This high consumption is due to the volume of water used for flushing the drains and watering the streets. There are two supplies, one direct from the Seine and Marne for municipal and other services, for which unfiltered water can be employed, and the other from river sources, supplemented by filtered and sterilised water from the Seine and Marne, for household distribution. The consumption of river water in 1928 was 282,000,000 cubic metres. The trouble confronting municipal water engineers is that all existing springs within a reasonable distance of Paris are utilised. There are five groups having a total length of mains of 370 miles, the latest being the Voulzie, which was terminated recently. Instead of taking the water as it issues from the springs, the mains are now carried to the water-bearing strata, and precautions are taken over a certain radius to prevent any possibility of pollution. Moreover, the Paris Municipality is obliged to return to the Voulzie the same quantity of water taken at the source, and that is done by a

main from the Seine with pumping plant, so that the Voulzie is almost entirely supplied with Seine water. As the supply of spring water is insufficient, it is supplemented by filtered and sterilised water from the Seine and the Marne, but that supply is limited by the navigation requirements and the limit is now practically reached. Therefore, the only way to insure ample provision for a number of years is to draw water from the supplies underlying the deep layer of find sand existing over a considerable area in the old bed of the Loire. The Paris water engineers have carried out complete and exhaustive tests and are convinced that a million cubic metres of perfectly pure water can be sent to Paris daily without reducing the subterranean level. However, it is proposed to meet local objections by the construction of a large barrage-reservoir which will serve to regularise the river Loire. How strong is this opposition was observable from the attitude of representatives at the Congress from the Vals de Loire district. Local opinion has been appeased by the appointment of a technical and scientific commission, which will investigate the effect of the withdrawal of this huge volume of water from the Vals de Loire. The population believes that the commission will condemn the scheme. If, however, it is favourable to it, the Paris Municipality will seek Parliamentary powers to proceed with the work.

It is possible also that, as a last resource, water may be obtained from the barrage-reservoirs which are to be constructed in the upper valley of the Seine. These were dealt with by Monsieur Suquet, who described the proposed barrage-reservoirs of Pannesière, Champaubert-aux-Bois, Crescent and Chaumeçon. These reservoirs will regularise the river Seine by accumulating water in times of flood and returning it to the river during periods of drought, and the power stations will supply quite a considerable quantity of electricity, the most important being the Pannesière with 18 million kWh a year.

Visits were arranged for members of the Congress to the St. Maur and Ivry pumping stations and filtering beds, and to the sewage farm at Achères. The St. Maur Station takes water from the Marne and delivers daily 99,000 cubic metres of unfiltered water and 95,000 cubic metres of filtered and sterilised water to the three main reservoirs at Ménilmontant, Montsouris and St. Cloud, whence it is pumped to secondary reservoirs in different parts of the city. The filtering is effected in two stages, the water drawn from the Marne undergoing a preliminary filtration through sand at more than double the rate of the final filtration. The sand lies to a depth of 27in. on permeable tiles made of a conglomerate of coarse gravel and a small binding of cement and reinforced with wire. The water passes freely through the tiles on to the floor beneath. The water is usually turbid and opaque. The sand of the preliminary filtering beds requires cleaning at short intervals, and that is done by means of tubes having at their extremities a number of jets at an acute angle, so that when a tube is pushed to the bottom of the bed the water under pressure drives all the lighter matter to the surface and the operation is facilitated by water being circulated at the same time from the bottom of the bed to the top, which is swept with brooms. The final filtering beds only require cleaning in the same way every three or four months. Another method which is sometimes employed, although not in Paris, is the Chavannes system of projecting less than a fifth of the same quantity of water through the sand bed by means of compressed air. The filters are now capable of supplying 150,000 cubic metres per day, and, with the additional filtering beds now being constructed, the quantity will be raised to 300,000 cubic metres. This quantity apparently cannot always be assured, as the filters are frequently laid up for cleaning.

The filtered water is delivered to an underground reservoir from which it is taken by the pumps, and at this stage the purity of the water is carefully controlled by laboratory tests, sterilisation by the addition of chlorine being resorted to. A German apparatus is employed for this purpose. Another method of sterilisation adopted at St. Maur is the ozone system by means of a plant which was laid down in 1912. Two years later it ceased operations, and the plant only started working again a few years ago, and on account of the cost it is really regarded as experimental. The installation is elaborate with electric generators, ozone batteries and mixing chambers. The current is transformed four times, the first three bringing down the tension to 120 volts for reasons of safety, and it is finally raised to 1500 volts for the ozone batteries. The latter consist of a series of electrodes, or "generators," as they are called, between condenser plates around which passes the air that has been dried by contact with calcium carbide. The electrified air then passes into the mixing chambers, where it remains in contact with a given volume of water for three to five minutes. As the water thus treated leaves the chambers it is violently agitated by cascades to relieve it of any excess of ozone. The capacity of the plant is 90,000 cubic metres a day. The cost of treatment is five to six times more than that of the chlorine process. The consumption of current per cubic metre of water is about 120 watts, but it varies according to conditions, particularly the humidity of the air, and the consumption descends occasionally to 75 watts. The makers of the plant believe that they will be able eventually to reduce the consumption to 15 watts.

The pumping plant at St. Maur is remarkably varied. The station was originally a water mill, and when it was taken over by the municipality in 1863 the hydraulic power was used with a horizontal axis Girard turbine and two Fourneyron turbines with vertical axes. There is a second hydraulic plant with two Fourneyron turbines. They each develop about 60 horse-power, and they drive pumps which supply unfiltered water to the Ménilmontant Reservoir. A little later there were installed three Farcot steam engines and double-acting piston pumps. These are also each of 60 horse-power. Then come the modern plants consisting of seven four-cylinder suction gas engines, each of 450 horse-power and three single-cylinder suction gas engines, each of 80 horse-power, all of them driving Rateau centrifugal pumps. The latest installation consists of six Rateau pumps driven by electric motors, each of 450 horse-power and capable of delivering 25,000 cubic metres of water a day. The pumping plant is amply sufficient to deal with the increased volume from the new filtering beds without diminishing to any large extent the supply of unfiltered water.

Visitors were then conducted to the new water tower which has just been constructed on the top of the hill of Montmartre, in order to provide the necessary pressure in the most elevated part of the city. Its total height from the ground is 140ft. The special feature of this tower, built of reinforced concrete, is that it stands behind the Sacré Coeur, and its design had to blend with the architectural features of that famous church. It is probably one of the most artistic towers of its kind yet constructed As with all the reservoirs, it has two concentric compartments, separated by an annular space, one for spring water and the other for unfiltered river water.

Institution of Electrical Engineers.

No. II.*

SUMMER MEETING.

SATURDAY, June 22nd, brought the Institution of Electrical Engineers' Summer Meeting to a close. As the President (Colonel Edgcumbe) remarked in his final speech, the outing surpassed the wildest expectations. Thanks to the Société Française des Electriciens, its President (Monsieur Bunet) and its secretary (Monsieur Grosselin), who met the party in Paris and remained with it throughout the journey, the whole affair proved a great success; it is doubtful, in fact, if any other engineers who have embarked upon similar excursions have been more satisfied with what they saw and experienced. There were naturally a few slight inconveniences. Meals were not always served as expeditiously as they might have been; guides were sometimes a little difficult to understand; and the time spent in certain works was altogether inadequate. But little troubles of this nature are invariably met with at summer outings. A praiseworthy feature of the excursion was that practically every section of the electrical profession was catered for. Power station engineers saw some of the most important stations in France; professors saw technical schools; wireless engineers, the large and important wireless station at Saint-Assise; electro-chemists, electro-chemical works; whilst transmission and distribution engineers had ample opportunity of studying the French overhead systems. The requirements of electric traction engineers were also well met by the visits paid to sub-stations and generating stations supplying the Midi Railway. The excursions in the Pyrenees were highly enjoyable.

For the most part the weather was fine, although rain was met with each time the party ascended the mountains. The members left Paris for Bordeaux on Sunday, June 16th, and broke the journey at Eguzon, where motor coaches, provided by the Union Hydro-Electrique, conveyed them to the dam and generating station of the Union. Afterwards the members proceeded to Saint Sébastien by way of the valley of the Creuse and the ruins of Crozan, and then continued their journey by train to Bordeaux, where they arrived shortly after 9 p.m. On the following morning, Monday, June 17th, the party left Bordeaux for Pau, where it inspected the railway rectifier station. In the evening a dinner was given by the South-Western Local Centre of the Société Française des Electriciens. After spending the night at Pau, the party left by motor coach to inspect the electrical installations of the Compagnie du Midi, which, incidentally, kindly provided free of charge the special trains for the Pyrenees portion of the meeting. These installations, which included the Hourat-Hydro electric 50,000 horse-power generating station and a 1500-volt rotary converter sub-station, proved of considerable interest. After lunch at the Hotel des Princes at Eaux-Bonnes, the members proceeded *viâ* the Col d'Aubisque to Lourdes, where they dined and slept. Lourdes, we need scarcely say, is the most famous pilgrimage centre of the Roman Catholic world, and receives pilgrims and sick persons from all over the globe. None save those who have visited Lourdes can form an idea of what an extraordinary place it is. The presence of so many sick and crippled people has anything but an elevating effect upon those who are apt to get depressed. It is said, however, that Lourdes bestows immense benefits upon many who visit the place. Apart from it being a unique religious city, it is classed as a tourists' centre of the first order, but, for our own part, we were not sorry when the time came to leave. On Wednesday, June 19th, a visit was paid to the Société des Phosphates Tunisiens at Soulom. After lunch at Gavarnie, an inspection was made of the generating station at Luz, which belongs to the Société des Forces Electriques de la volte de Gavarnie, and the Société Hydro-Electrique de la Cère, and which contains three 11,000-kVA Pelton wheel machines. Back again in Lourdes, the members were left to amuse themselves in the evening in whatever way they pleased.

The following morning, Thursday, June 20th, the members left by motor coach for Lannemezan, where they were supposed to inspect the works of the Société des Produits Azotés (nitrogen compounds). Unfortunately, however, the coaches did not reach these works until a quarter of an hour before the train was due to convey the party to Toulouse. The result was that anything beyond a rapid glance at certain parts of the factory was impossible, and the most sensible people confined themselves to the refreshments. Toulouse was reached about 3 p.m., and in the evening the Mayor received the members at the Town Hall, where champagne flowed in abundance. The next and last day of the excursion was devoted to a visit to the famous old city of Carcassonne, which, as everyone knows, deserves more than a casual inspection. Viollet-le-Duce, who restored it, said: "I do not think there exists anywhere else in Europe such a complete and formidable collection of eleventh twelfth, and thirteenth century defences, such an interesting object of study or a more picturesque situation." Built in a fertile plain between the Montagne Noire to the north and the Corbières to the south, the town is divided into two parts by the river Aude—the so-called new town and the Cité, the history of which goes back to the remotest times. The idea of taking the party to Carcassonne was indeed a happy one, but it is regrettable that so short a time could be spent there.

FIG. 1—EXTERIOR VIEW OF LABORATORY

From the foregoing and from what appeared in our last issue it will be realised that to describe in detail all that was seen is out of the question. We shall therefore confine ourselves to a few brief remarks on things of special interest, and in the first place get back to Paris or rather to what was known as the Paris section of the meeting, covering visits outside Paris. Among these visits was one to the testing laboratory of the Compagnie Electro-Céramique at Ivry, an important company specialising in the manufacture of porcelain insulators. The firm is said to be the largest and oldest of its kind in France, and the first to manufacture suspension insulators for 150,000 and 220,000 volts. It supplies insulators of all kinds, ranging from small insulators for low pressures up to the largest working at the highest pressures now in use. The company's factories are now capable of producing 8000 French tons of insulators per annum, or nearly double the pre-war production. The building of the laboratory—an exterior view of which is given in Fig. 1—is an extensive structure and contains high-pressure transformers—see Fig. 2. There is a testing section and a raised platform, from which the insulators undergoing test can be observed without danger. As darkness is essential to testing work of this nature, no windows have been provided, but, as can be seen from Fig. 1,

* No. I. appeared June 21st.

there is a large shutter at one end of the building, which enables high-pressure conductors to run from the building into the open so that insulators may be tested under working conditions, or, at any rate, under conditions that resemble them very closely. There are three transformers, a control desk and regulating

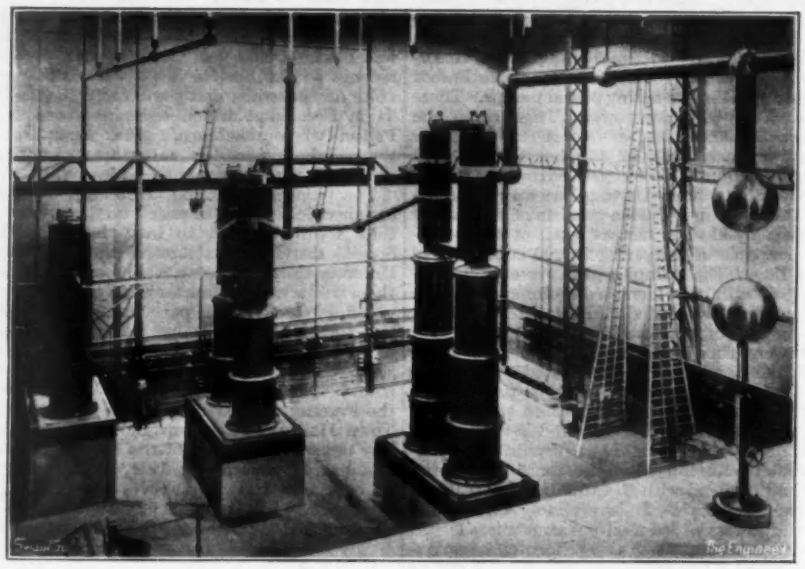


FIG. 2—HIGH-PRESSURE TRANSFORMERS

gear. Three-phase current is supplied to the laboratory at a pressure of 5000 volts, but this pressure is reduced to 200 volts for the operation of the testing motor converter, which consists of a self-starting synchronous motor coupled to an alternator generating current at 500 volts and at a periodicity of 50 cycles

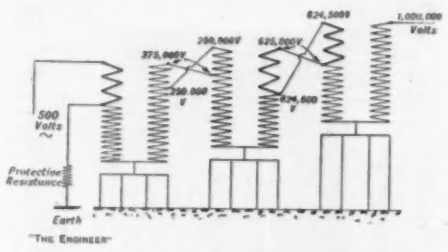


FIG. 3—CASCADE CONNECTIONS

per second. The generator, which supplies current to the transformer has been specially designed in order that it may give a wave free from ripples, and all the six stator leads have been brought out to terminals so that the windings may be connected in star or mesh. The motor is of the well-known kind that starts as an induction machine and is subsequently excited with direct current, when it runs as a synchronous motor. The exciter, which is mounted on the converter shaft, generates at 115 volts. In the three cascade-connected transformers—see Fig. 2—the use of oil has been avoided. Reduced weight, easy inspection and repair are among the advantages claimed for these transformers. Contrary to what many might suppose, these transformers are perfectly satisfactory and have operated well in the face of very adverse conditions. During a week in January of 1924 the laboratory was flooded owing to rise in the level of the river Seine, but apparently the dampness to which the windings were subjected did no damage. The transformers, as the diagrams Figs. 3 and 5 show, are of the auto type with a capacity of

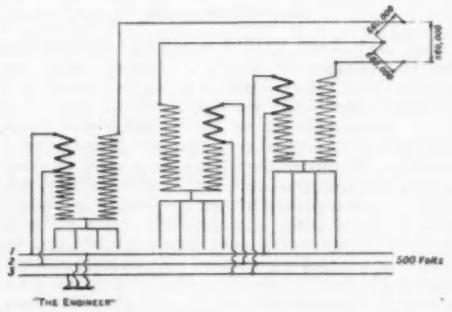


FIG. 5—TRANSFORMERS CONNECTED ACROSS SUPPLY PHASES

125 kVA. Although all the three transformers are identical, owing to their mountings they stand at different heights, as shown in the illustration Fig. 2. Each transformer is mounted upon a block of reinforced concrete to protect it from immediate contact with flood water. If desired, the transformers can be used individually with an output of 125 kVA at a pressure of 375,000 volts to earth. They may also be connected in parallel in order to obtain a bigger output. By coupling the three transformers in cascade, as shown in Fig. 3, a pressure of one million volts to earth can be obtained. The first transformer is fed with current at a pressure of 500 volts derived from the motor generator. The system of connections shown in Fig. 5—where it will be seen that the primary of each transformer is connected to one of the phases of the supply system—gives a pressure of 650,000 between the phases. The change from one system of connections to another is easily made by means of suitable gear. In the laboratory the high-tension conductors are made of tubes composed of a material known as "Haefelyte," coated internally with a layer

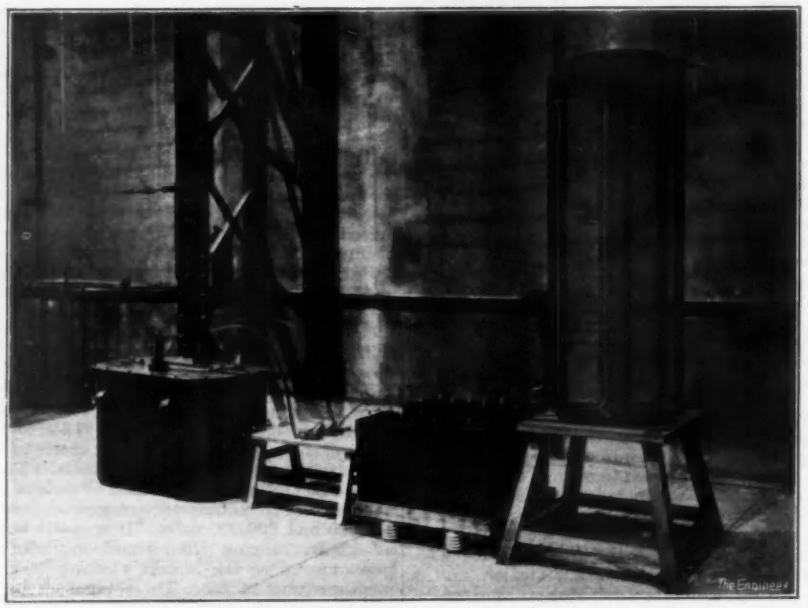


FIG. 4—HIGH-FREQUENCY TESTING APPARATUS

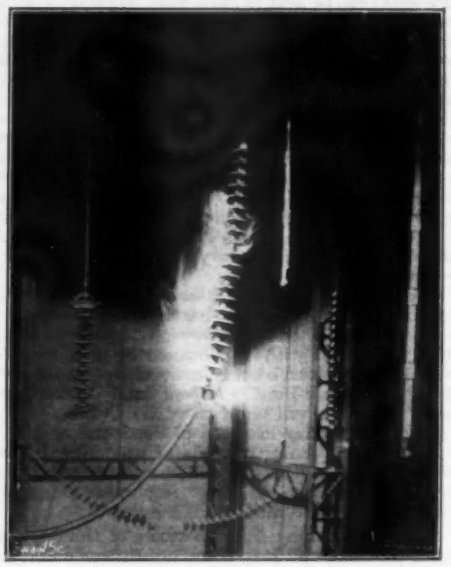


FIG. 6—FLASH-OVER ON CHAIN INSULATOR

of Dutch metal, the diameter of these tubes varying with the pressures they have to deal with, the actual diameters being 10 cm., 20 cm., and 30 cm. The conductors are joined together by brass spheres with diameters of 150 mm., 300 mm., and 500 mm., suspended from the framework of the building by tubular porcelain insulators 6 m. long. All control gear and measuring instruments are concentrated on a desk, with three panels. For measuring the high pressures used in this laboratory the company has adopted a special method, developed by Emile Haefly and Co., based on the determination of the

FIG. 7—MILLION-VOLT ARC

charge of a condenser of known capacity connected between the source of high tension and earth. For high-frequency testing work the apparatus shown in Fig. 4 is employed. It comprises a transformer connected to the supply through a regulator, a spark gap with zinc electrodes, a battery of condensers, and an inductance, to be seen on the right of the illustration. The test potential can be raised to 300,000 volts, whilst the frequency can be varied from 200,000 to 500,000 periods.

Dry tests are made within the laboratory, where insulator chains are suspended from above and connected with the high-pressure conductor. A flash-over on a chain insulator is shown in Fig. 6, whilst Fig. 7 shows a million-volt arc between points. Tests

on bushings can be carried out at pressures up to 600,000 volts, whilst the lower part is immersed in oil at temperatures up to 90 deg. Cent., so that transformer terminals are tested under conditions as near as possible to those met with in practice. Rain tests are made in the open, the chain to be tested being suspended at the anchorage of the test line, which is 135 m. long, and can be put under pressures up to 600,000 volts between phases. Here again, therefore, the insulators are tested under working conditions. Finally, we should mention that a machine has been specially developed by the Company for applying combined mechanical and electrical tests to insulators.

(To be continued.)

International Foundry Congress.

No. III. *(conclusion).**

ONE of the most interesting and important discussions of the Congress took place on Thursday, June 13th, in the main hall of the Institution of Mechanical Engineers, and dealt with the testing of cast iron. Mr. Wesley Lambert—President of the Institute of British Foundrymen—was in the chair. The discussion concerned :—(*a*) A paper from France ; (*b*) another from Mr. J. G. Pearce, of the British Cast Iron Research Association ; and (*c*) a report on the shear test by the Institute of British Foundrymen's Test Bar Committee.

The French exchange paper was by Messieurs A. le Thomas and R. Bois, and it dealt in a comprehensive manner with the French point of view on this matter. The question of testing cast iron, which has so greatly interested foundrymen of all countries for several years, has been studied by numerous investigators, but agreement as to the most suitable test has not yet been reached. The controversy rages round whether the test to be employed should be tensile, shock, shear, static transverse, or hardness, or a combination of several of them. Also, ought the test pieces to be cast separately or taken from the casting ? Monsieur le Thomas had already stated the case for the shear test or the static-transverse test applied to bars taken from the castings or by ball testing the castings themselves, and the present paper is a strong plea for the adoption of the shear or Fremont test, and the practical abolition of all others, the paper containing a specification for testing engineering castings by that method. The advocacy of the shock and tensile tests in this country are strongly criticised on the ground, among other things, that the test bar is cast separately, it being argued that whilst such a test bar may have the same composition as the main casting, there is no possibility of its having the same crystalline structure, owing to the difference in the conditions under which the cooling of the casting and the test bar is carried out. Further, it is argued that separate test bars are liable to differ from the main casting in that the founder is liable to pay special attention to them, to the detriment of the casting itself. "It is much easier," say the authors, "to fake a separate test bar." Therefore, to sum up, the paper from the French workers points out that the separate test bar is incapable of representing a casting, and no arguments can exist to justify the method of testing based on its use. We must be very careful not to assume that because a metal has given excellent tests on separate bars, it will produce castings of excellent quality.

The nature of the tests proposed by the authors is outlined as follows :—(1) Shear tests preferably on a test bar taken with a trepan drill from a casting, but, if necessary, on a piece taken from a cast-on boss ; (2) hardness tests for the purpose of judging homogeneity, made on parts with the skin removed ; (3) if required, and under certain special conditions, static transverse tests on a bar taken from the casting or from a cast-on boss ; (4) if necessary, and under certain special conditions, compression tests on a test bar taken from the casting or from a cast-on boss. This method is urged as being superior to, and likely to give more reliable results than, the method adopted in this country of carrying out tensile, static transverse and shock tests on bars cast separately.

The paper by Mr. J. G. Pearce, of the British Cast Iron Research Association, dealt, generally, with the influence of size of section on the strength of grey cast iron and did not deal specifically with the method of test. It was, however, a paper by the same author which was read before the Sheffield Branch of the Institute of British Foundrymen two years ago that was quoted at some length by Messieurs le Thomas and Bois, and criticised in a manner which drew from Mr. Pearce in the subsequent discussion some rather "straight" comments, the Sheffield paper being selected by the French authors for the reason that it contains the general arguments against their own particular point of view.

The report of the Institute's Test Bar Committee states that much time has been devoted during the past year to a consideration of the claims put forward for the Fremont shear test, with the object of ascertaining to what extent this test might supplant, with safety, the ordinary tensile and transverse tests now in use, and what advantage it would be to the inspecting engineer and the foundryman. In considering this question the following two questions were kept in view :—(1) That the engineer, when inspecting much of the work in this country and abroad has no other guide to the quality of the metal in the castings than that given by the results obtained from one or two simple tests. (2) Having obtained a Fremont shear test result, what does that result mean to the designing engineer ? It is claimed that the Fremont test results can be converted into tons per square inch.

The following are, briefly, the findings of the Committee :—

> The Fremont test piece is trepanned from the casting by means of a hollow drill. . . . We find that such test piece is rarely true to dead size or perfectly round. Jolley found the most carefully trepanned test pieces to be 0·007in. oval and small. Moreover, he proved that a reduction of only 0·001in. from the true diameter caused an alteration of the ratio between the shear result and the tensile ; indeed, each such reduction caused another change in the ratio. These results demonstrate the extreme difficulty of trepanning a true test piece, and the worthlessness of the results if the piece is not true.
>
> We find that the 0·22in. diameter test piece is too small for concordant results under all conditions. Using samples taken from a 2in. by 1in. bar, Pearce obtained 12·6 tons, 11·65 tons, and 13·4 tons—all from 0·22in. diameter test pieces. From the same bar, but using 0·5in. diameter test pieces, the results were 17·3, 17·7, and 16·8 tons. Thus the larger diameter test pieces give results 25 per cent. higher than those of the smaller ones. Jolley's work confirms this observation.
>
> But were the 0·5in. diameter test piece adopted, the size of the hole made by the trepanning drill would be seriously objected to by some engineers, and this apart from the difficulty of breaking off these larger pieces without damage.
>
> On Jolley's testing machine—which is the nearest approach to ideal on account of its hardened ground slides—one sample gave 21·7 tons ; but on Cameron's machine the same sample gave 16·22 tons ; whilst on the B.C.I.R.A. machine, which is similar to the pattern adopted in America, it gave 17·15 tons. It was noted also by the B.C.I.R.A. that when the edge of the shear tongue is used, the test figure falls by about 3 tons.
>
> Over a period of twelve months, Jolley cast many bars, 14in. by 1in. by 1in. Some of these bars were cast attached to castings, whilst others were cast separately. From each of these bars Jolley made tensile, transverse and Fremont shear tests, using a 0·5in. diameter test piece for the latter. He found that the ratio of shear to tensile varied from 1·37 to 1·84.
>
> We point out that the above finding means that a 10-ton tensile iron might show anything from 13·7 to 18·4 tons tensile, if tested by the Fremont test and the tensile calculated from it in accordance with the claims made by supporters of this test.
>
> Pearce's findings confirm Jolley's. Pearce found the ratio to vary from 1·07 to 1·92 on fourteen irons of varying composition. Hyde, working on two mixtures, obtained a ratio varying from 1·20 to 1·42.
>
> Shaw got 0·99 from a turbine mixture, but 1·91 from a hard phosphoric mixture.
>
> Cameron's ratio ranged from 1·04 to 1·17 over six mixtures. It is to be remembered, however, that his bars were cast $\frac{1}{2}$in. diameter, and the tensile machined to 0·564in. diameter, and the shear to 0·5in. diameter.
>
> In every case—here in the United States and in Professor Siegle's paper given at Paris in 1923—the highest ratio of the shear over the tensile occurs on low-tensile irons. Jolley got a shear of 17 tons on a 9·5-ton tensile iron, and of 28·0 tons on a 20·5-ton tensile iron. Pearce, with a 9·8-ton tensile iron obtained 18·7 tons shear. The same applies to the ratio between shear and transverse.
>
> The position from which the piece is trepanned is vital in some cases. Using a somewhat soft mixture, Hyde found that a $\frac{1}{8}$in. sample taken from the centre of a 2in. by 1in. section gave 3 tons less than two other samples taken on either side.
>
> Having thus proved conclusively that no constant ratio exists between the Fremont shear test value and the tensile test value of the cast irons of commerce, your Committee cannot advise the Council to support the adoption of the proposed Fremont shear test for commercial specifications.

The discussion on these three contributions was opened by Mr. John Shaw, Chairman of the Test Bar Committee, who, naturally, put up a further defence of the point of view of the Committee and of the tests adopted in this country. At the same time he assured our continental *confrères* that the British Committee was working with no other object than to serve a common interest, and that if a better procedure than that now adopted in this country could be produced and agreed to, it would receive our wholehearted support, no matter where it came from.

Mr. J. T. Mackenzie, of the American Foundrymen's Association, remarked that whilst the French and the British had arrived at some unanimity of opinion as individual nations—although in different directions—there seemed to be as many different opinions on this subject in America as it was possible to have. At the same time it was felt in America that all of the tests now in use were too valuable to be disposed of merely by adverse criticism.

Mr. J. G. Pearce—Director, British Cast Iron Research Association—spoke with a certain amount of feeling regarding the comments in the French paper concerning himself. Whilst the B.E.S.A. specifications embodied tensile and transverse tests, we did not, he said, seek to impose them on any other country, and we were prepared to discuss their disadvantage frankly with a view to improving them. We in this country were prepared to examine carefully any new tests without hasty judgments, but must have overwhelming evidence of the advantages of any new proposal before undoing all the work that had already been done. That evidence, he contended, was not forthcoming in the shear test or in the particular form of single shear test on a small bar advocated by Fremont. We ought to know whether this shear test was used throughout France, whether it was specified by consulting engineers, local governing bodies, railways, and so on, and whether it was recommended in any French national specification or in those of other continental countries. The shear test was not new to us. It was described in the text-books, and it was familiar to all testing engineers ; but there was, in fact, no demand for the single shear and only a feeble demand for double shear tests on any materials. The fact that Fremont and Portevin had, to use the words of the French paper, "absolutely condemned" the tensile test, did not kill it in England.

Mr. Pearce spoke somewhat sarcastically with regard to certain passages of the French paper which criticised his Sheffield paper, and commented upon the special pleading of the two French authors, which, however, it was added, did nothing to upset the obstinate facts they criticised. He added that the paper went on "with devastating logic to completely impracticable conclusions which had been repeated so often by the authors and Portevin about the necessity for small test pieces, trepanning, &c.," and asked how many foundrymen would care to make castings to the specifications quoted in the paper, and whether such castings were likely to be worse than those supplied under British specifications. When he read the French paper and noticed its tone, he thought that in the minds of our French friends two things must keep us from adopting the shear test—one was natural depravity and the other ignorance ; but we erred in good company, viz., that of the United States. Finally, Mr. Pearce said he would be sorry to make any comments that overstepped the bounds of courtesy or that were not in the best interests of technical controversy, but he called to memory the famous natural history book which said : "The so-and-so is a very ferocious animal ; it defends itself when attacked," and he promised to deal with the authors a little more thoroughly in a written communication.

Mr. W. Jolley spoke as an advocate of the British tests.

Mr. H. J. Young doubted whether our test showed the strength of a cast iron any better than the French test and endeavoured to pour oil on troubled waters by suggesting that we should get closer together by stating what our test is intended to show, and then ask the French to state, in a similar manner, what their test is intended to show, afterwards endeavouring to arrive at one test which would give those results.

The President also pleaded that the discussion should be conducted in a "happy" atmosphere.

After all this, there was not a great deal of importance in the remaining discussion, except several expressions of goodwill toward the French authors in an endeavour to remove the impression of ill-feeling that might have been engendered by some of the previous remarks. From the chair and from the body of the hall Messieurs le Thomas and Bois were assured of the appreciation of what had been done in France in the endeavour to elucidate this matter, and Monsieur Ronceray—who had presented the paper in the absence of the authors—in acknowledging these sentiments, remarked that France was willing to accept any test that was internationally agreed upon, and had no desire to thrust the shear or any other test upon other nations.

A paper by Mr. C. F. Gillott—Research Department, Woolwich—entitled "The Critical Examination of Steel Castings," outlined the use of X-ray examination in connection with which the President suggested that we must not be too hopeful of this method, as it must be a long time before such a test could be accepted for general workshop use. He added that he believed most of the work hitherto done on steel with X-rays was on castings that were known to be defective, and therefore it was known where to look for the fault. What we wanted was to know whether a new casting was likely to fail.

Two American delegates mentioned that X-ray examination is specified in many cases in America for small castings.

The President agreed that the method is much more hopeful for small castings—he had referred in his previous remarks to small castings—and it seemed to him that it would take a very long time thoroughly to explore a large casting by means of X-rays.

* No. II. appeared June 21st.

Another interesting discussion at the Congress on June 12th was upon three papers dealing respectively with the influence of chromium, manganese, and nickel in cast iron, the authors being Dr. J. W. Donaldson, Dr. A. L. Norbury, and Dr. A. B. Everest.

The first paper, dealing with the addition of chromium to cast iron, gave the results of an investigation carried out for Scott's Shipbuilding and Engineering Company, Ltd., and indicated how chromium added to grey cast iron in quantities up to 0·90 per cent. increases the stability of the combined carbon up to 550 deg. Cent. Further, it was shown how small additions of chromium reduce very slightly the corrosion of grey cast iron. The effect is most noticeable with sea water, and to a lesser extent with strong acids. With weak acid, tap water, and ammonium chloride, little advantage is gained.

Dr. Norbury described a series of experiments carried out for the British Cast Iron Research Association on castings sent to the Association by its members, and reports an indirect graphitising action by the addition of manganese, due to its combining with and neutralising iron sulphide, the normal action of the manganese being to stabilise iron carbide and to increase the tendency to chill.

The paper by Dr. Everest deals only with the addition of small amounts of nickel in grey cast iron, but he points out that higher percentages of nickel find use in cast iron of various grades in virtue of its influence in rendering the structure austenitic. Whilst the influence of nickel on the properties of cast iron has been well established, the paper demonstrates that the action of nickel leads to material improvement in the production of high-quality cast iron in the foundry, and in the subsequent handling in the machine shop. The use of nickel in cast iron tends towards a greater uniformity of product, obviously of great value in production work, where variation in machineability is to be avoided. The paper indicates the lines along which nickel is successfully and economically finding application in cast iron.

Mr. Field, in discussing manganese, mentioned that Derbyshire iron gives less trouble with draws and shrinkages than Northamptonshire iron, and said that he had come to the conclusion, as the result of hundreds of experimental heats, that the manganese in the Derbyshire iron—which was higher than that in the Northamptonshire iron—has a great deal to do with the immunity of the Derbyshire iron from shrinkage.

Mr. J. Longdon, referring to the suggestion that the addition of nickel reduces porosity, said that he had recently cast a gear blank without reducing the silicon, but adding about 2 per cent. nickel, yet porosity showed itself in the rim nevertheless.

Mr. John Shaw asked for information as to the effect of adding small quantities of manganese to thick sections. As to nickel, he mentioned some cylinders for air compressors to withstand a pressure of 3000 lb. per square inch, and said that, whereas with a specially refined iron poor results were obtained, the addition of 1 per cent. nickel produced castings which showed no leakage under test.

Mr. H. J. Young, speaking on nickel, mentioned a meeting at which a chief chemist of a foundry said that by putting from ½ to 1 per cent. nickel into the metal he had considerably reduced costs by getting rid of wasters. On the other hand, another chief chemist at the same meeting said that he had added nickel, but still did not get rid of the wasters. More definite evidence on this matter was therefore required, said Mr. Young.

Mr. E. Longden asked for information as to the cost of adding nickel to cast iron.

Dr. Norbury, replying on the question of adding manganese to thick sections, promised to carry out experiments, but suggested that when certain information was obtained as to what happened in small sections, the results with thick sections could at once be predicted.

Dr. Everest, replying to the question as to cost of adding nickel to cast iron, said that it might mean 15 to 20 per cent. on the cost of a casting, but the longer life, reduction of wasters, and improved service amply justified the extra cost.

The Congress was an unqualified success, and the only criticism, on the technical side, would be that too many papers were put forward for discussion, and that although the discussions, generally speaking, were up to a high standard, there was not sufficient time to do full justice to them by oral discussion.

The social side of the Congress was equally successful, and the appreciation of the overseas delegates for the manner in which they had been received here found expression in promises from the delegates from all countries to return the compliment when the opportunity arose, coupled with a cordial invitation to any British foundryman to visit their countries in a private capacity at any time, and be shown over the foundries there. Twelve countries were represented at the Congress.

DURING 1928 nearly 250 million pounds of carbon black were produced in the United States, and for this purpose it is estimated that 175,000 million cubic feet of natural gas were burned.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

"OLD CONTEMPTIBLES."

SIR,—Do any of your readers know what is supposed to become of mechanical engineers at fifty years of age? Are we supposed to be shelved permanently and our years of experience to be of no value compared with the College training without the practical experience of men and machines?

In spite of twelve years arduous toil as works engineer of one of the largest factories in London; every year bringing its gain in knowledge; in spite of having afterwards earned £1000 a year in a little business with a capital of £350 and an everlasting bank overdraft (brought to an untimely end through a nervous breakdown) I find myself at the age of fifty on the scrap heap. I have answered over three hundred advertisements in six months with only one reply. In this particular instance, which was a vacancy for a works engineer at £700 a year, I attended before the board of directors, and was about to be appointed, when the chairman remarked, "Oh, I don't think you have mentioned your age," and when I replied that I was fifty, he said, "Well, I don't think we need detain you any longer." The cream of the joke was that he was about eighty, and the managing director about seventy. Both would have been grossly insulted had anyone suggested they were too old to build up the magnificent business they had control of.

What is to become of we "old contemptibles," Mr. Editor? Never anticipating the present state of things, no doubt most of us have lived up to our income, and nothing but the workhouse looms ahead unless we are lucky enough to find a job as timekeeper or night watchman.

Are we not as brainy and businesslike as ever? As keen in initiative and organisation? I believe so, but being fifty years of age, this age of youth says, "It need not detain us any longer"; but where are we to go to, Sir? What are we to do? The only suggestion I have yet heard is to shave clean and always remain forty-five. A lie? Yes, but necessity will ever ignore the law in the absence of any better solution.

"JOHN OF AYLESTONE."

Leicester, June 20th.

METHOD IN INVENTION.

SIR,—I have been very interested in the correspondence on my paper, which follows generally the discussions I have had with other engineers. Practically all critics are up against the idea that invention can be helped by method. When it is applied to existing machines the critic remarks that the machine in question was produced without the methods and therefore they are unnecessary. When the methods are used to produce new ideas, he says that these, of course, have not been tested and may be useless.

Point out to him that some apparently simple ideas have taken about fifty years to evolve and that they might have been evolved in five years by means of the methods, and he is not interested. Personally, I think that this attitude is due to the fact that English people are trained to rely on text-books, and they find it difficult to get hold of ideas which do not pertain to text-books. I have no doubt the methods will ultimately be taken up by the Germans and Americans, and we will then have to pay a heavy tribute to them in the way of patent royalties. After some years of this we will doubtless decide to make use of the methods ourselves, and then will find them very beneficial. The methods cannot be learned in half an hour, but those who persist in their use for a year will find them invaluable. C. TURNBULL.

North Shields, June 21st.

GRAND JUNCTION RAILWAY LOCOMOTIVES.

SIR,—The engine "Locomotion" referred to, was originally No. 135 Bat, built at Crewe, July, 1852, a 6ft. single Trevithick design. Three additional engines, 6ft. singles, were built at Crewe in the first half of 1846, viz., 4 "Hecate," 25 "Harpy," and 44 "Harlequin."

The authority for the statement that 73 was "Prince" and 19 "Princess," both 6ft. singles, is an official printed list of the locomotives as at the end of June, 1846, which has been inspected by the writer, in which the highest number is given as No. 83 "Windermere." It is not known for certain what type of engines Nos. 65 to 72 were, but most probably they would be 0–4–2's with inside cylinders, and similar to Nos. 30 and 41. The leading engine in the Whitmore collision on the early morning of February 11th, 1841, was 65 "Charon" and not 72 as stated, No. 67 being the train engine. The *Manchester Courier* of February 13th, 1841, gives a detailed account of the accident.

I am unable to furnish any additional particulars about Bolton and Leigh engines 123 or 127, or of the North Union engines 174 to 184. W. LAIDLAW.

Manchester, June 22nd.

RAINHILL LOCOMOTIVE TRIALS OF 1829.

SIR,—With the permission of the Rainhill Gas Company, I have recently opened out and measured up the cylinder of the "Novelty," which is in their possession, and which was used for driving a hoist until a few years ago. The internal dimensions of the cylinder are:—Length, 15¼in. bare measurement; internal diameter, 6¼in. exact; width of piston, 2 $\frac{9}{16}$ in.

From these measurements and the known particulars of the "Novelty's" two sets of cylinders, it appears that the cylinder has been re-bored at some time, and that, allowing for clearances, the cylinder had a 12in. stroke and is one of the original cylinders with which the "Novelty" was fitted at the time of the trials. Unfortunately, the cylinder has been stripped of the two side rods, &c., and probably the only original parts that now remain are the cylinder barrel and the top cover.

In the search for information in connection with a Centenary Lecture which I have in preparation, I have found no other actual relic of the trials at Rainhill.

B. WELBOURN.

Rainhill, near Liverpool, June 22nd.

North-East England Electricity Scheme.

THE Central Electricity Board has just published the following particulars regarding the North-East England Electricity Scheme, 1929:—

AREA.

The scheme deals with an area of about 5050 square miles, covering the counties of Northumberland and Durham and a part of the North Riding of Yorkshire. The area had a population at the last census of approximately 2,674,800, and embraces densely populated industrial areas dealing with coalmining, shipbuilding, iron and steel, engineering, and chemical trades. It also covers wide tracts of agricultural territory which, with a few isolated exceptions, are at present unprovided with any system of electricity supply.

EXISTING AUTHORISED UNDERTAKERS.

At present there are thirty-two authorised undertakers in the area, owning between them fifteen public generating stations. The consumption of electricity in 1927–28 was about 247 units per head of the above-mentioned population. It is estimated that this will increase to an average of 410 units in 1935–36.

SELECTED STATIONS.

Under the proposals, six existing stations will be selected and operated for the Board, namely, Carville (A), Carville (B), Dunston, North Tees, Darlington, and Sunderland. It is not anticipated that any new stations will be required, but the scheme provides for five further stations to be worked under temporary arrangements for a few years. There are several waste heat and private generating stations connected up to the system of undertakers in the area, and it is assumed that these undertakers will continue the arrangements already entered into with the owners of these sources of supply.

Broadly speaking, four of the selected stations—namely, Carville (A) and (B), Dunston, and North Tees—will supply the base load, while the remainder will be used for meeting the peak load. It is thought that in due course it will be possible to reduce the number of peak load stations required.

TRANSMISSION SYSTEM.

The stations will be interconnected by a series of high-pressure main transmission lines designed in a series of ring mains, so that there will be alternative routes to points of supply, and consequently greater security against breakdown. The ring mains are not necessarily completed in the present scheme, but the primary transmission system has been laid out so as to permit of amplification hereafter under schemes for adjoining areas. The main transmission system will comprise 102 route miles of line and five transforming stations. The secondary transmission system will involve a further ten transforming stations. Incidentally, the interconnection of these stations will result in the release for revenue-earning purposes of about 80,000 kilowatts of plant now kept as spare, and representing about £1,360,000 of capital.

STANDARDISATION OF FREQUENCY.

The greater part of the electrical development in this area has been carried out on a non-standard frequency of 40 cycles. The scheme contemplates standardisation in twenty-five undertakings, the work being carried out over a period of years in stages, and in such manner that no further 40-cycle generating plant beyond that already sanctioned shall be installed in the area of the scheme by the undertakers concerned. The estimated eventual cost of standardisation is £5,963,070.

COST OF THE SCHEME.

The cost of the scheme to the Board for the erection of the transmission system is estimated at £1,131,467. In addition, there will be an expenditure by undertakers of about £775,000 on extensions of certain existing stations. It is estimated that the full advantages of the scheme can be secured with a saving of about £2,040,958 on capital expenditure—up to the year 1935–36—as compared with the capital expenditure that would be necessary if the present system were continued. After this date the saving on capital expenditure would be progressively greater as compared with individual development.

ESTIMATED SAVINGS.

The Commissioners have outlined a provisional plan of working the stations with the necessary estimates. These suggestions are, of course, tentative, since the working of the scheme, including the fixing of tariffs, is the responsibility of the Board, but taking the figures as they stand, it is interesting to note that the Commissioners estimate that in the five years 1931–36 there will be a saving to the undertakers in the area of about £382,173.

Two-Stroke Double-Acting Marine Oil Engine.

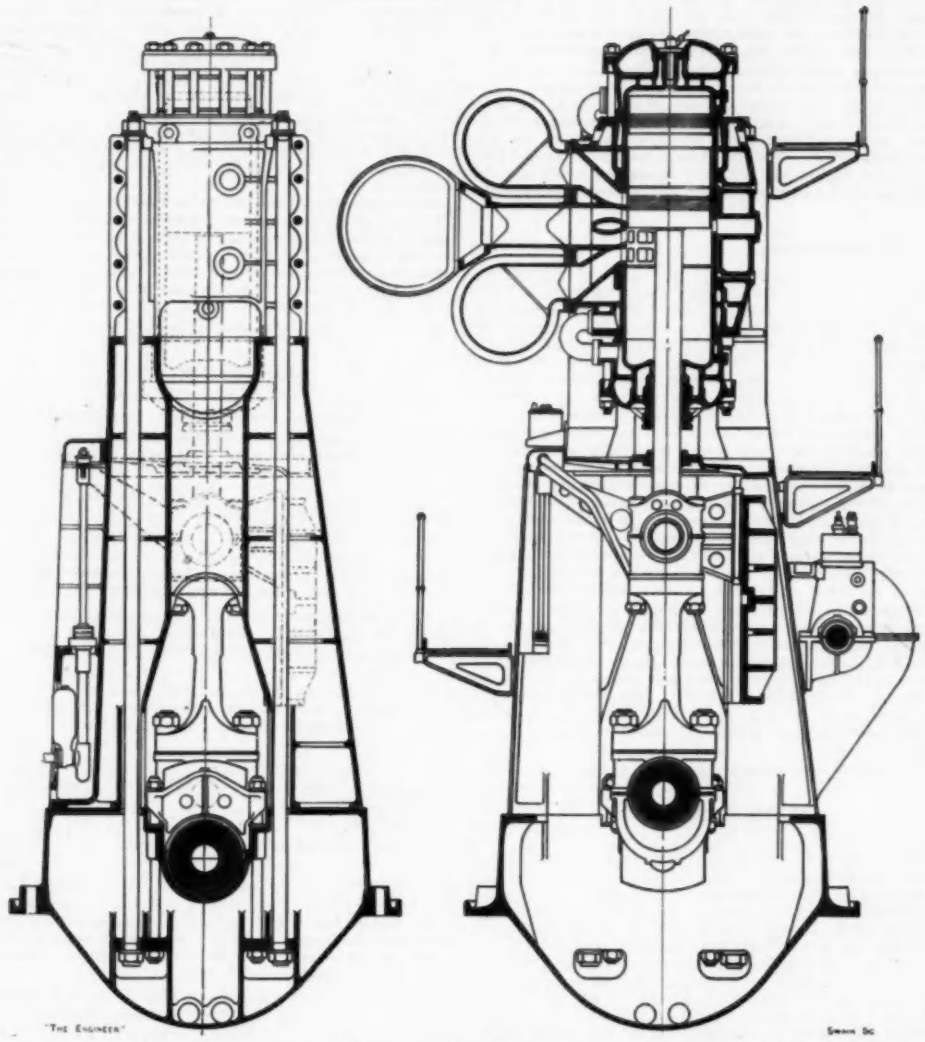
WE recently received, through John Le Boutillier, Ltd., the London representatives of the Maschinenfabrik-Augsburg-Nürnberg A.G., a report on the development of the M.A.N. two-stroke double-acting oil engine, which has been prepared by Mr. Heinrich Becker, the chief engineer of the marine department at the company's Augsburg works. From it we take the following notes.

The type of engine with which the report deals has already on more than one occasion been described and illustrated in THE ENGINEER. In this respect we would refer more particularly to our articles of March 26th and April 2nd, 1926, in which, following a visit to the Augsburg works, we described the 4400 S.H.P. six-cylinder two-stroke double-acting oil engine which was built for the German-owned cargo vessel "Ramses" and gave particulars of the patented scavenge system adopted, details of cylinder and valve construction, and the ship trials. Although this was one of the first marine engines of its particular type to be completed, the actual construction of two-stroke engines was begun in 1924, and, taking the period up to the end of 1928, eighty engines, we are informed, have been built by the parent firm and its licencees, with a total of 485 cylinders and a designed output of about 348,000 B.H.P. In Germany, during 1928 alone, out of a total of twenty-eight motor vessels completed, seven were fitted with two-stroke double-acting M.A.N. engines, aggregating 323,000 S.H.P. The proportion of such engines installed in ships built up to the end of 1929 is over 6 per cent. of the total, which figure, it is estimated, will probably reach 15 to 18 per cent. during the present year. In the success of this engine the M.A.N. scavenge system has undoubtedly played an important part. It will be recalled—as indicated in the accompanying drawing—that the scavenge air and exhaust ports are arranged on the same side of the cylinder liner, and that the entering scavenge air in the upper end of the cylinder is deflected across the piston, up the opposite wall of the liner, then across the cylinder cover, and down to the exhaust ports at the centre of the cylinder. The same cycle of operations takes place in the lower end of the cylinder. The effectiveness of this method of scavenging is confirmed by the high mean indicated pressures up to 8 kilos. per square centimetre, or nearly 114 lb. per square inch, which can be obtained with a clean exhaust. In high-speed double-acting engines up to 900 B.H.P. per cylinder output and 300 r.p.m. continuous operation at mean indicated pressures of about 80 lb. to 90 lb. per square inch are readily obtained. The same method of scavenging is suitable for such large units as that of the 15,000 B.H.P. nine-cylinder engine in the Neuhof power station at Hamburg—see THE ENGINEER for June 28th, 1926—and for engines down to the very smallest sizes. Recent engines which have been delivered can operate, we are informed, with a ratio of scavenge air to stroke volume of 1·35 against ratios of 1·65 to 2·0 for other systems of scavenging. In this respect the following average figures taken from recent ships are of interest :—

Name of ship.	Main engines. I.H.P.	Main engines. S.H.P.	Bore and stroke in millimetres.		No. of cyls.	R.p.m.	Scavenge air pressure in mm. water column.	Power taken by blowers, B.H.P.	Percentage of total I.H.P. for scavenging.
M.V. "San Francisco"	4500	3750	700	1200	5	87	800	130	2·9
M.V. "Trave"	5500	4600	700	1200	6	82	900	165	3·0
M.V. "Burgenland"	6000	5000	700	1200	6	95	1000	228	3·8
M.V. "Seattle"	6400	5400	700	1200	7	85	1000	204	3·2
M.V. "Palatia"	3800	3200	600	900	6	120	850	153	4·0

Outstanding among motor passenger ships propelled by double-acting engines of this type is the largest motor vessel in the world, M.V. "Augustus," with four engines aggregating 28,000 S.H.P., which, after being fitted with new piston-rods and a modified piston cooling water arrangement, has continued since the second voyage to give consistently good service, running at an average service power of 25,000 S.H.P. and at about 119 r.p.m. Recent ships built in Germany include the geared motor vessel "St. Louis," with four Vulkan-M.A.N. engines aggregating 12,200 S.H.P. She is fitted with gearing and hydraulic flexible couplings reducing the speed from 225 r.p.m. at the engines to 110 at the propellers. The sister vessel, the "Milwaukee," which will be shortly placed in service and is being built by Blohm and Voss, will have similar engines, but direct gearing. In France a large passenger liner is now in course of construction and will be propelled by four M.A.N. engines totalling 18,000 S.H.P.

In view of the very large powers which are being considered for the new Transatlantic liners, it is of interest to mention one or more of the proposals mentioned in Mr. Becker's report which were recently put forward and considered, in which M.A.N. double-acting engines are arranged as direct-coupled and as oil-electric installations. An advantage of the two-stroke as compared with the four-stroke engine for equal outputs is the shorter stroke and narrower engine bed-plate, which fact enables arrangements showing a saving in engine-room space of 40 per cent., to be designed. Examples are given in Mr. Becker's report of a 10,000 S.H.P. equipment with four twelve-cylinder main engines and oil-electric generator and compressor sets. A 120,000 four-shaft geared arrangement with sixteen ten-cylinder high-speed engines and auxiliary engines, and finally an 180,000 S.H.P. oil-electric propulsion installation comprising eight sets, each driven by two ten-cylinder high-speed engines designed to develop 11,500 B.H.P., or 23,000 B.H.P. per set, are worked out. It is interesting to note that these engines would operate on the airless injection principle and that the weight per B.H.P. without the electrical machinery works out at 25 kilos. In the new German armoured cruiser "Ersatz Preussen" geared two-stroke double-acting engines of 50,000 B.H.P. are being installed and the engine weight per B.H.P. is still less.



VERTICAL SECTIONS THROUGH 12,000 B.H.P. TWO-STROKE DOUBLE-ACTING M.A.N. ENGINE

A COMPARISON OF TYPES.

A section of Mr. Becker's report is devoted to a comparison of the two-stroke double-acting type of engine with two-stroke single-acting and four-stroke double-acting engines of about the same designed output. The results obtained may be conveniently summarised in the following table :—

Item.	Two-stroke. Double-acting.		Two-stroke. Single-acting.	Four-stroke single-acting.
Cylinder bore, mm. ..	650	700	820	840
Stroke, mm.	1,200	1,200	1,440	1,500
B.H.P. output	7,040	7,040	7,040	7,000
Number of cylinders ..	8	7	8	8
R.P.M.	105	105	100	100
Average piston speed in metres per second ..	4·2	4·2	4·8	5·0
Mean indicated pressure, kg. per sq. cm.	4·95	4·95	5·2	5·12
Mean brake pressure, kg. per sq. cm.	5·9	5·9	6·34	6·56
Overall height, mm. ..	9,200	9,200	10,000	11,000
Weight in kg. per B.H.P., including scavenge blower	65	66	110	126*
Weight of running parts in kg. per cylinder line	6,500	7,470	9,430	12,960
Weight ratio	1·0	1·15	1·45	2·0

* Without blower.

In a further section of the report the dynamic factors of turning moment, torsional vibration, balancing and bending vibration are considered. In passing it may be mentioned that one diagram shows that the line on which the specific gravity of the two-stroke double-acting engine falls is 730 mm., or nearly 29in., lower than that for a single-acting two-stroke engine of equal power, namely, 7040 S.H.P. at 100 to 105 r.p.m. The turning moment diagrams for three-cylinder engines with 120 deg. cranks also show the great advantage of the two-stroke double-acting principle, while the critical speeds are shown to be fewer and less harmful in their effect than in other forms of engine. Particularly good cylinder arrangements are the five and seven-cylinder units, and these results are attested by the torsiograph records referred to and reproduced in Mr. Becker's reports. In this respect we may refer to the very quiet running of the engine of the Hamburg-America liner M.V. "Seattle," a seven-cylinder, 700 mm. bore and 1200 mm. stroke engine, which showed by measurements taken at the upper cylinder cover that the side movement was scarcely perceptible without special measuring instruments and did not exceed at any time more than plus or minus two-tenths of a millimetre.

Some Constructional Details.—The two sectional views of the engine given in the accompanying drawing represent the cylinders of an airless injection engine of 12,000 B.H.P. output with 600 mm. cylinder bore and a 900 mm. stroke, generally similar to the sets built for the Maerkische Electricity Works in Berlin, and illustrated in THE ENGINEER for August 3rd, 1928. Nearly a month later, on August 31st, we also gave a fully illustrated description of the 4000 B.H.P. four-cylinder M.A.N. air injection engines built by Vickers-Armstrongs, Ltd., for the submarine mother ship H.M.S. "Medway," which has recently been commissioned. The drawings we reproduce herewith serve to show some important details of construction in the latest type of M.A.N. two-stroke double-acting oil engine. We may call attention to the through-going tension bolts which connect the cylinder casing to the bed-plate, and to the deep bolts for the main bearing caps. These are clearly shown in the left-hand view, which also illustrates the very neat way in which the cooling water pipes from the piston are housed outside the crank case on the main column castings. The simplified arrangement of the cylinder covers and jackets with their liners may also be noted. The design of these parts is such that, by the aid of a support, the lower cover with its liner can be quickly dismantled for inspection. The piston-rod stuffing-box is a comparatively short one, and by the careful cooling arrangements adopted all the parts subject to heat stress are kept at very moderate temperatures. Tests made on a 700 mm. bore, 1200 mm. stroke engine running at 90 r.p.m. show a liner temperature near the top of only 135 deg. Cent., with 54 deg. at the outer flange at the top of the liner, 80 deg., at a point below the lower piston rings, and 53 deg. near to the scavenge air ports. These figures are for a mean indicated pressure of 6·3 kilos. per square centimetre, or about 90 lb. per square inch, and for 80 lb. pressure, or 5·8 kilos. per square centimetre, they are 110 deg., 50 deg., 75 deg. and 50 deg. for the four respective positions.

BURTON Town Council has decided to abandon the whole of the remaining tramway system in the borough and to purchase eighteen "Guy" omnibuses from Wolverhampton at a total cost of £23,560.

Obituary.

H. J. S. MACKAY.

THE death is announced of Mr. Henry John Sutherland Mackay, the General Manager and Managing director of the Stirling Boiler Company, Ltd., as having taken place in London on Wednesday, June 19th.

Mr. Mackay was educated at Hillhead High School, Glasgow, and at the Glasgow and West of Scotland Technical School. In 1889 he was apprenticed at the works of Alexander Chaplin and Co., Ltd., of Govan, thereafter obtaining drawing-office and engine shop experience with D. and W. Henderson, Ltd., of Partick. The years 1894–98 were spent at sea as a marine engineer in the service of Messrs. Maclay and McIntyre, shipowners, of Glasgow, during the last two years as chief engineer in charge. From 1898 to 1902 he was with the National Boiler and General Insurance Company, Ltd., of Manchester, first as inspecting engineer and later as assistant chief engineer. Since 1902 he had held, successively, the positions of Engineer, London Manager, and General Manager and Managing Director of the Stirling Boiler Company, Ltd.

Mr. Mackay was a Member of the Institution of Mechanical Engineers and an Associate Member of the Institution of Naval Architects.

American Engineering News.

Changing a City's Topography.

IN its rapid growth in size and commercial importance the city of Seattle, on the Pacific coast, has been hampered by its peculiar topography, with numerous hills and ravines of steep slopes, coming down almost to the shore line of Puget Sound. In 1905 the city adopted a policy of "regrading," cutting off hilltops and using the material to fill valleys or ravines, and to form a level bench along the water front. One of the first pieces of this work was to lower the summit of Denny Hill by about 110ft., requiring the removal of 5,400,000 cubic yards of material, most of which was broken down by powerful water jets and sluiced to its new position. The latest project, now in progress, contemplates about the same total excavation, but the material is handled by belt conveyors instead of being sluiced through troughs, as it has to be carried through a built-up portion of the city to the water front, where it will be delivered to barges for discharge at certain parts of the harbour. Large power excavators will deliver the excavated material into hoppers, from which it will be fed to nine conveyors. Six of these will be portable, being shifted as the excavators progress. They will be 250ft. long. The others are fixed or non-portable, ranging from 950ft. to 1625ft. in length, supported on elevated trestle work and completely enclosed in wooden galleries. All the belts are 3ft. wide. In all this regrading work there is much difficulty in maintaining streets and in carrying the material without serious interruptions to the city's business and its local transportation systems.

Car Retarders in Sorting Yards.

In the short space of five years a marked change has been made in the operation of classification or sorting yards by the extensive use of car retarders or rail brakes. Under the ordinary system in gravity switching or shunting, each car or cut of cars is controlled by a brakeman or car rider, who rides the car from the summit of the hump into the sorting yard and controls it by the hand wheel of the brakes. This requires a large force of men and some special arrangement—usually a motor car on a central line of rails—to return the men to the hump. In addition, the work is hazardous, as the men have to cross numerous tracks in going from the goods cars to the motor car. There are two systems of operating the retarders. First, all-electric, in which all points, retarders and rail skates are operated directly by electric motors; secondly, pneumatic-electric, in which compressed air motors are electrically operated and controlled. Both systems are considered preferable to the hydraulic system used in Europe. The retarders are pairs of beams fitted with renewable shoes, which, by toggle connections, are caused to grip the car wheels passing between them, the force of grip being varied according to the speed of the car and the distance it has to run. Some of the large yards with thirty to fifty-two classification tracks have twenty-five to eighty sets of retarders, each set including both rails. The retarders may be supplemented by fifteen to forty sliding skates, but some yards do not use the skates.

Low-temperature Coal Carbonising Plant.

The largest American plant for the carbonisation of coal at low temperatures is now in operation at New Brunswick, New Jersey, and a second large plant is being built as auxiliary to a steel works at Coatesville, Pennsylvania. At the first of these plants, the production of a ton of coal gives, at one operation, 1500 lb. of smokeless fuel, 3500 cubic feet of gas of 900 B.Th.U., 25 gallons of tar and 2½ gallons of light oil. The fuel is of porous structure, and ignites more readily than coke; about 1200 lb. is of commercial size, while 300 lb. goes as fuel for steam boilers and to supply producer gas for heating the carbonising retorts. There are eight retorts, each with a capacity of 80 to 100 tons of coal daily. The retort consists of two concentric revolving cylinders, 5½ft. and 10ft. in diameter, the smaller one 85ft. and the other 72ft. long. Crushed coal fed in at the lower end of the smaller cylinder is carried by spiral blades to the upper ends, where it drops through openings and then passes down in the outer cylinder, reaching the discharge opening in about two hours from the time of charging. Steam is admitted to the retort to prevent carbon deposits. A temperature of about 1200 deg. at the lower end and 1350 deg. at the upper end is maintained. The coked or carbonised fuel is passed through a dry quencher and then screened, all sizes of ¾in. and larger being sold, while the finer stuff goes to the gas producers. Steam from two boilers at 200 lb. pressure is used to operate the machinery, the exhaust steam being utilised in the carbonising process. This plant can handle 250,000 tons of coal annually.

A Large Coal-handling Plant.

At the steam-operated central generating station of the Consumers' Power Company, at Zilwaukee, the increase of capacity to 70,000 kW, with plans for doubling that figure in a few years, has necessitated changes in the coal-handling plant. Railway cars deliver coal to an underground hopper by dumping through bottom doors, but a car-dumping machine will be installed later. On one side of the coal tracks is a storage yard with capacity for 75,000 tons when piled to a height of 16ft. On the other side is a crushing plant. From the track hopper the coal flows by gravity to a belt conveyor, delivering to the crusher bins or directly to a steeply inclined belt conveyor, 250ft. long, leading to the boiler-house, where a 300ft. belt running the length of the building feeds into any one of the ten 140-ton bunkers. Coal for storage goes to a short conveyor running in the opposite direction, and discharging into the storage yard. There a cable-operated scraper system with a bucket of 7 cubic yard capacity distributes the coal over the stock pile, and serves also to reclaim coal as needed and feed it to the crusher plant, which can handle 250 tons an hour. All the belts can handle 350 tons an hour. The scraper works within a radius of 400ft. from the head post, the tail blocks of the cables being attached to a self-propelled tower moving on rails laid along the outer boundary of the stock pile. The electric hoist is mounted in a cab at one side of the head post and all movements of the cables, bucket and tail tower are controlled from an operating-room on the conveyor gallery. With an average haul or head of 270ft. the 7-yard bucket can handle 275 tons an hour, and the substitution of a 10-yard bucket will increase this capacity to 375 tons.

A Floating Tunnel.

Simultaneously with the construction of the suspension bridge of 1850ft. span across the Detroit River to connect Detroit with Windsor, Canada, a highway tunnel is being built under the river. This tunnel will be a steel tube about a mile in length, with an outside diameter of 32ft. and providing a roadway 22ft. wide. For the river section, about 2500ft. long, a trench is being dredged in the stiff clay of the river bed to a depth of about 80ft. below mean water level. Here the tube will consist of ten lengths of 250ft. each, built on launching ways, bulkheaded at the ends, towed into place and sunk by depositing concrete by means of tremies into the annular space between the shell or tube and planking attached to the stiffening rings or diaphragms that surround the tube. This outside casing of concrete is to be 24in. thick, while the interior will have an 18in. lining of reinforced concrete. Divers will adjust the locking connections between adjacent sections, the joint being then enclosed with a ring of concrete. When the concrete has set, the interior bulkheads will be removed. Finally, the trench will be filled, covering the tunnel with 10ft. of clay. A similar method of construction was employed several years ago for the Michigan Central Railroad tunnel under the Detroit River. The land approach tunnels are being driven by hydraulic shields, 32ft. in diameter, and will be lined with ¾in. steel plate instead of the usual cast iron segments. Within this steel shell will be the concrete lining.

SIXTY YEARS AGO.

THE degree to which the safety of boilers against explosions has been improved during the past half-century or so may be in some measure gathered from the remarks which we made in our issues of June 18th and 25th, 1869, concerning a disaster which had occurred at Bingley. "Explosions of fire-damp and explosions of steam boilers," we wrote, "are unfortunately so numerous that they attract no particular attention unless they involve all the elements of a great tragedy." The loss of a dozen men in a pit, the killing of two or three in a mill scarcely, we said, excited a moment's thought in the great mind of the public. Occasionally, however, the country was startled out of its propriety by catastrophes which were too fearfully suggestive to be passed over without attention. Such a disaster was that which had just occurred at Bingley. "A little trumpery boiler, some 18 horse-power or so," in the works of T. Town and Son, bobbin turners, had exploded with great violence. Six persons in the works had been killed and in the playground of an adjoining school nine children lost their lives. Thirty other people, of whom fourteen were children, had been severely injured. The boiler, it seems, was an old one, which had been taken out of service, repaired and re-sold. The safety valve was of an out-of-date pattern, known to be dangerous, and was overloaded. The plates of the boiler had been made of defective material to begin with, and had been extensively weakened by external corrosion. Finally, the repairs had been carried out inefficiently. Mr. Fletcher, chief engineer to the Manchester Steam Users' Association, in a report to the coroner, estimated that at the time of the explosion the boiler was under a pressure in excess of 100 lb. per square inch. The coroner's jury returned a verdict of manslaughter against the engine tenter, one of those who had lost their lives, but added that the greatest possible blame attached to Messrs. Town, the occupiers of the mill. The jury recommended that all steam boilers should be placed under Government inspection. This verdict was so different from the usual one returned in similar circumstances that we hailed it with pleasure. We did not agree that the charge of manslaughter should be returned against the dead tenter. Others, we held, bore a far greater degree of responsibility for the disaster. But that a coroner's jury should bring in a verdict of manslaughter against anyone in connection with a boiler explosion was an admirable sign of increasing knowledge. The disaster had taught a fearful lesson. We hoped that another would not be required to induce a member of the House of Commons to introduce a measure rendering the inspection of steam boilers, either by Government officials or by some company of recognised standing, a necessity.

B.E.S.A. SPECIFICATIONS.

ELECTRICAL INSTRUMENTS.

REVISIONS of British Standard Specifications Nos. 89 and 90, dealing with Indicating Instruments and Graphic (Recording or Chart-recording) Instruments respectively, have recently been issued. The technical requirements of these new specifications are similar to those of the previous editions, with the important exception, however, of clauses dealing with the marking of the instruments and the issue of test certificates.

In the past, difficulties have been experienced in connection with the provision of the independent test certificate required under the conditions governing the use of the British Standard Mark "BeSa," and in order to facilitate matters, a *Report* is now called for in place of the *Certificate* originally required. The substitution of the report for the certificate arises from the fact that "certificates" issued by the National Physical Laboratory have acquired a special significance of their own in the eyes of the public, as something in the nature of a guarantee that the article concerned is a satisfactory one, quite independently of the British Standard Specification covering the article submitted for test. What is often required, however, is a plain statement from the Testing Authority to the effect that the article submitted—in this case the instrument submitted—conforms in certain respects to the appropriate British Standard Specification. Such a statement is now provided as a Report, and the information to be furnished in the Report is clearly stated in the Specification.

The significance of the use of the British Standard Mark "BeSa" on an instrument is also clearly defined in the new Specifications, copies of which (Nos. 89, 1929, and 90, 1929) may be obtained, price 2s. 2d. *each* post free, from the Publication Department, British Engineering Standards Association, 28, Victoria-street, S.W. 1.

BOOKS RECEIVED.

The Advertisers A.B.C., 1929. London: T. B. Browne, Ltd., 163, Queen Victoria-street, E.C. 4. Price 21s. net.

De Afsluiting en Gedeeltelijke Droogmaking van de Zuiderzee. Amsterdam: N. V. Handelsdrukkerij Holdert & Co. Price, post free, Fl. 1·30.

Groundwork of Calculus. By Wm. Hunter, M.A., B.Sc. London: University Tutorial Press, Ltd., High-street, New Oxford-street, W.C. 1. Price 5s. 6d. net.

Problèmes de Statique graphique et de Résistance des Matériaux. By Louis Roy. Paris: Gauthier-Villars et Cie., 55, Quai des Grands-Augustins (6e). Price 30f. net.

The Civil Engineers' Reference Book. Twentieth edition. Third issue. By J. C. Trautwine. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 35s. net.

Twenty-first Annual Report of the Hydro-electric Power Commission of the Province of Ontario for the year ended October 31st, 1928. Toronto: The Legislative Assembly of Ontario.

The Institution of Structural Engineers, Year Book and List of Members, 1929. London: The Institution of Structural Engineers, 10, Upper Belgrave-street, S.W. 1. Price 5s. net.

Standard Methods of Testing Petroleum and its Products. Second edition. London: The Institution of Petroleum Technologists, Aldine House, Bedford-street, W.C. 2. Price 7s. 6d. net.

Annali dei Lavori Pubblici (già Giornale del Genio Civile), Ministero dei Lavori Pubblici, Consiglio Superiore. 1929, Fasc. No. 3, Marzo. Rome: Provveditorato Generale dello Stato, Libreria.

Annali dei Lavori Pubblici (già Giornale del Genio Civile), Ministero dei Lavori Pubblici, Consiglio Superiore, 1929 *Fasc. II., Febbraio.* Rome: Provveditorato Generale Dello Stato, Libreria.

New Zealand Shipping Freights and Charges, Report of Discussions by Wellington Harbour Board Concerning the Flat Freight Rate System. Wellington: Published by the Harbour Board. 1928.

Bio-precipitation Studies, 1921–1927. State Water Survey Bulletin No. 25. By A. M. Buswell, R. A. Shive, and S. L. Neave. Illinois: State Water Survey, Urbana, Ill., U.S.A. Price 50 cents net.

Workshop Practice. Vols. VII. and VIII. Edited by E. A. Atkins, M.I. Mech. E., M.I.W.E. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 6s. net per volume.

The International Aspects of Electrical Communications in the Pacific Area. By L. B. Tribolet, Ph.D. London: The Oxford University Press, Amen House, Warwick-square, E.C. 4. Price 11s. 6d. net.

The Year Book of the Bermudas, the Bahamas, British Guiana, British Honduras, and the British West Indies, 1929. London: *Canadian Gazette*, Ltd., 330, Gresham House, Old Broad-street, E.C. 2. Price 7s. 6d. net.

Electrical Transmission and Distribution. Vols. VII. and VIII. Edited by R. O. Kapp, B.Sc. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price, Vol. VII. 6s. net, Vol. VIII. 3s. net.

A Study of Factors Affecting the Efficiency and Design of Farm Septic Tanks. Illinois State Water Survey Bulletin No. 27. By E. W. Lehmann, R. C. Kelleher, and A. M. Buswell. Illinois: State Water Survey, Urbana, Ill., U.S.A. 50 cents net.

Railway and Road Matters.

THE London and North-Eastern is providing eight of its expresses between Marylebone and Bradford and Manchester with new rolling stock which include kitchens, wherein the cooking is done by electricity only.

THE locomotive coaling plants provided at the London and North-Eastern engine depôts at Doncaster, Whitemoor and Hitchin have given such satisfaction that similar facilities are being given at Hatfield, Hornsey, Cudworth and Kipps.

IT is sixty-nine years ago since the first railway was opened in South Africa. It was the Point Railway, Durban, and was 2 miles long. To-day the Union Government Railways cover over 13,000 miles and its road motor services a further 9716 miles of route.

THE Pullman cars on the Great Western Railway, mentioned in this column on May 31st, are to form a complete train of first and third-class cars, to be known as the Torquay Pullman Limited, which is to run every Friday and Monday, leaving Paddington at 11 a.m., for Newton Abbott, Torquay, and Paignton and return the same day at 4.30 p.m.

IN connection with the article entitled "The Detection of Flaws in Rails," which appeared in our issue of May 10th, we have received a letter from Mr. Elmer A. Sperry, in which he informs us that the Sperry Development Company has, by means of the method described in our article, now examined about 900,000 rails, among which it has detected some 1400 fissures.

SOON after the Somerset and Dorset Joint Line was extended to Bath, the Midland and London and South-Western Companies ran a through carriage to and from Plymouth, but it was not a success. We are reminded of that service by the forthcoming provision of through carriages by the same route between Nottingham and Sidmouth, Budleigh Salterton and Exmouth.

THE summer train services will be brought into use this year on July 8th. The 10 a.m. from King's Cross and the 10 a.m. from Edinburgh will again run non-stop to their respective destinations, as will the 11 a.m. from King's Cross to Scarborough. The London, Midland and Scottish response is that the 10 a.m. from Euston will again run to Kingmoor shed, on the north side of the city of Carlisle, where engines will be changed. A similar run will be made by the corresponding up train.

ACCORDING to the *Far Eastern Review*, Mr. H. S. Chuck, managing director and chief engineer for the unfinished portion of the Canton–Hankow Railway, has reported on his inspection trip over the proposed route linking up Chuchow (in Hunan) with Shiuchow (in Kuangtung province). Mr. Chuck was accompanied by Mr. J. Weir, Consulting Engineer to the Ministry. He will arrange to start construction of the first 31-mile section of the line from the northern terminus of the Kuangtung end. The estimated cost for building and equipping this section will be approximately 7,000,000 dollars, and noteworthy engineering features include a bridge of seven spans with a total length of 760ft. at Shiukwan, and a 1400ft. tunnel at Kaolin, which is about half finished.

THE Severn and Wye Railway, which is jointly owned by the Great Western and London, Midland and Scottish companies, operates between the Ross and Monmouth branch of the Great Western and Berkeley-road Junction on the Bristol and Gloucester section of the latter railway. It works through the Forest of Dean and owns the Severn Bridge. Owing to motor omnibus competition the passenger trains are shortly to be withdrawn. The Bullo Pill Railway ran from a place of that name on the river Severn to Coleford and was the original section of the Severn and Wye. It was absorbed in 1826 by the Forest of Dean Railway, which had been sanctioned in 1809. Remarkable to relate, the latter retained its name and separate entity until incorporated in the Great Western under the Railways Act, 1921.

THE Ministry of Transport railway statistics for March last, recently published as a Stationery Office publication, price 3s. 6d., remind us that the Easter bookings of 1928 fell into the corresponding period. Despite that fact there was an increase in 1929 of 3·1 per cent. in the number of passengers and of 12·8 per cent. in the passenger receipts. Moreover, this additional traffic was carried with 1·0 per cent. fewer passenger train-miles. Thanks to an increase of 6·5 per cent. in the quantity of coal, coke, and patent fuel carried there was a rise of 1·3 per cent. in the tonnage of freight, but the freight receipts, owing to the increase being in lower rated traffic, were down by 2·1 per cent. As explained in our issue of May 31st, when dealing with the statistics for February, the average load per wagon of coal is thrice the average of general merchandise and, therefore, owing to the increased tonnage being in coal, the freight train-miles had a decrease of 3·5 per cent., the average train load increased from 130¼ tons to 137¾ tons, and the net ton-miles per engine hour from 445½ to 448¼.

IT was the first anniversary on Thursday, June 27th, of the disastrous collision at Darlington, when twenty-five passengers were killed. That was, with the exception of the Armagh disaster of June 12th, 1889, and the Quintinshill of May 22nd, 1915, the worst accident since the Hexthorpe collision of September 16th, 1887. The mention above of the Armagh catastrophe shows that it is just forty years since that happened. Because of the eighty passengers killed then, that was, with the sole exception of the Quintinshill disaster, the worst accident on the railways of the United Kingdom. It is worth noting that the three outstanding accidents on the railways—the Tay Bridge, Armagh and Quintinshill—occurred in Scotland and Ireland, and that the first mishap in which more than six passengers were killed was also in Ireland—at Straffan, on October 5th, 1853. It is due to the Irish railways that, as a set-off against the record just named, we should say that no passenger has been killed in a train accident since the two at Kinsale on January 28th, 1915, and that there have been only six fatal accidents since Armagh. In five of those only one passenger was killed in each; the sixth was Kinsale mentioned above.

Notes and Memoranda.

SOME of the farmers of Alberta have adopted the practice of ploughing at night-time, with the aid of tractor headlights. The object is to gain time, and the scheme is said to work well.

AN official cablegram from Singapore to the Malayan Information Agency in London gives the stocks of rubber on May 31st at Singapore as 26,764 tons; in Penang, 5168 tons; in Malacca, 1782 tons; Province Wellesley, 105 tons; and Dindings, 59 tons, a total of 33,878 tons.

IT is announced that Mr. A. J. Speed, chairman of the Photographic Section of the Preston Scientific Society, and an Associate of the Royal Photographic Society, has made discoveries which may revolutionise speed photography. He has taken photographs at 1-5000 of a second and believes he can attain much higher speeds.

A ONE-PIECE flag pole of Douglas fir, 184ft. long, has been presented to the Canadian National Exhibition at Toronto by the Timberland Lumber Company, Ltd., of New Westminster. The flag pole has a 34in. base and 10in. tip. It is estimated to be 275 years old, and was obtained on the timber limits of the company between Ladysmith and Nanaimo.

THE explosion of a condenser is unusual, but one has just been reported. The apparatus was used in a by-product plant to condense benzine. The tubes corroded rapidly and had to be renewed frequently. On such occasions their tightness was tested by the admission of low-pressure steam. It was overlooked that the shell also was corroding away, and during one test it exploded, a workman being scalded.

CONFLICTING views exist in America as to the future of the foundry-facing business. Some feel that the larger employment of sand-blast, welding, and die-casting equipment in foundries will make less necessary the fine finish on the castings that graphite facings are designed to produce, and that this fact will cut down the demand for graphite for this purpose. On the other hand, the sand used for cleaning castings is expensive, and the number of castings is steadily increasing.

ONE of the air locks used on a caisson being used in connection with the Hackensack River bridge parted from its shaft on May 29th. The air pressure was released, mud filled the caisson and six men were smothered. The lock was welded to its shaft, and it is estimated the joint would stand a load of 200 tons. The air pressure produced a load of 22 tons. It is suggested that a spoil bucket, which was being hoisted out, caught the lock and tore it away, but the hoisting rope had a breaking strength of only 25 tons.

IN paving about 2000 square yards of Hanover-avenue, at the east end of the Hamilton-street bridge in Allentown, Pa., the standard concrete mixture by very ordinary manipulation was made strong enough to take traffic the second day after placing. The specifications required, as for all other concrete paving, that a 1 : 2 : 3 mix be used with a 1½-minute mixing period. Inspectors saw that the full mixing period was used on all batches and that the concrete was placed as dry as would permit satisfactory working. The concrete work was carried out in the autumn of last year.

IN concluding a report on the effect of sieve motion on screening machinery, Messrs. Fahrenwald and Stockdale, of the American Bureau of Mines, state that a critical amplitude and frequency of vibration at which maximum screening efficiency is obtained exist for each size and density of sand screened. The amplitude of vibration for maximum screening efficiency is directly proportional to the size of sand screened. The frequency of vibration for maximum screening efficiency is inversely proportional to the size of sand screened. Under the conditions of these experiments the rate of screening for thick beds is less than for thin beds.

IN a recent lecture before the Royal Institution, Dr. E. M. de C. Andrade said that in vacuum production it becomes particularly necessary to examine what takes place at the inside surface of the exhausted vessel, that is, in an electric lamp, at the inside surface of the glass. Cold surfaces readily bind on themselves a layer of condensed gas, a process utilised when high vacua are produced by a bulb full of cold charcoal, which mops up the gas. Ordinary surfaces always have such a layer on them, unless special precautions are taken; and these surface gases are liable to come off and spoil the vacuum. By special methods the last traces of gas in an electric lamp or thermionic valve can be bound permanently to the walls.

THE tallest reinforced chimney on the American continent is said to be that erected in 1927 at the plant of the Horne Copper Corporation, Noranda, Rouyn District, Quebec. It is 422ft. 6in. high from the base to the top of the shaft, and 18ft. in diameter inside the lining at the top. Its base consists of a reinforced concrete ring, 17ft. 6in. deep and 35ft. outside diameter and 23ft. inside diameter, and the shaft, which is designed to withstand effects of acidic gases within, has a capacity of 550,000 cubic feet of gas per minute at temperatures from 300 deg. to 400 deg. Fah. The International Nickel Company has under construction at the present time at Copper Cliff, Ontario, a chimney of even greater proportions. It will have a height of about 600ft., and a shaft of approximately 50ft. diameter.

NEW retaining wall and soil research work at the Massachusetts Institute of Technology includes several interesting items, according to a recent statement by Professor C. M. Spofford. Under agreement with the New England Power Construction Company, the Institute will make experimental studies of earth pressure on retaining walls, with a special view to measuring the intensity of backfill pressure, effect of surcharge, effect of saturation, and value of various means of drainage. The Institute will furnish the site and foundations, together with miscellaneous facilities, while the company will build the structure above foundations and provide the bins and loading and measuring devices. As a separate research, a study of the heaving of soil under frost action is being carried on as a piece of co-operative work between the Department of Soil Mechanics and the U.S. Bureau of Public Roads.

Miscellanea.

A GRAND National Exhibition is to be held in Nanking in 1936.

IT has been decided to erect a new refinery at Copper Cliff, Ontario.

THE trunk telephone connection to the Isle of Man has been formally opened.

THE old Stanningley Ironworks, Leeds, are to be closed down, after a century of useful service.

AN Industrial and Commercial Exhibition is to be held at Dar-es-Salaam, East Africa, in September.

THE sea has broken into the Matushima Mine, Japan, and imprisoned fifty miners. Part of the mine has been abandoned.

IT is proposed to construct a vehicular tunnel to connect Brooklyn and Queens with Manhattan, New York, at a cost of 105,000,000 dollars.

AN ironfoundry covering a site of approximately five acres is to be put up at Calgary, Alberta, by the Authes Foundry Company, of Toronto.

THE Moscow Town Council has decided to build a new works with a capacity of 125,000,000 bricks a year in the sand quarry region near Lyublin.

A FACTORY for the preparation of asphalt, imported from the mines at Mariel, has been equipped at Preston Docks by the Anglo-Cuban Asphalt and Bitumen Company.

THE new 165,000-kW steam turbo-generator of the United Electric Light and Power Company, New York, installed at Hell Gate, has been formally put in operation.

AREAS amounting to 65,200 square miles were photographed aerially in Canada last year, and since 1923 the total area photographed has amounted to 262,645 square miles.

ARRANGEMENTS have been made for Mr. G. Clarke, Superintending Engineer, Burma, India, Public Works Department, to inspect flood control works on the Mississippi.

IT is proposed to build a suspension bridge over Williamette River, Portland, Oregon. It will be 3850ft. long, 50ft. wide, and have a clearance of 205ft. The clear span will be 1207ft.

IT has been stipulated by the authorities in New York that the proposed North River Bridge must have a clearance of 200ft. above mean high tide at the centre and 185ft. at the sides.

THE White Mud Falls, Manitoba, are to be utilised for power development, and a station with an ultimate capacity of 300,000 horse-power is to be erected. The first unit will be of about 40,000 horse-power.

THE boring of a second shaft in the Solikamsk potash field has been begun, and the Potash Trust has begun the construction of a powerful electrical power station on the field to serve the two shafts and all the subsidiary plant.

THE first of two petrol cruisers for the Canadian Customs preventive service was recently launched from the Montreal yard of Canadian Vickers, Ltd. She and her sister ship, which is to be launched in August, are 172ft. long by 21ft. beam.

IT is announced that preparations for the inauguration of an inter-provincial air mail service for the Kwangtung and Kwangsi provinces of China are nearing completion. Four main lines connecting Canton with various important cities of the provinces will be operated first.

THE new tug for Durban Harbour, which was built by Sir W. G. Armstrong, Whitworth and Co., has arrived safely at her destination after a voyage of thirty-three days. She is 170ft. long by 34ft. 6in. beam and has engines of 3500 horse-power. Her speed is 13 knots. The boilers are of the Babcock and Wilcox type.

WORK on the Steel Company of Canada's new dock at Hamilton, Ontario, has been started. It will be 3000ft. long and will extend from the plant far into the bay. The building of the new dock, it is stated, is the beginning of an extension programme that will involve the expenditure of several million dollars in the course of the next few years.

IT is proposed to arrange wharfage facilities for shipping manganese ore at Durban. The loading plant is to have a capacity of 400 tons an hour and is to be supplied by the Wellman Smith Owen Company. Its cost will be approximately £40,000, and a storage yard capable of accommodating 50,000 tons of ore is also to be arranged.

A 60-ton bridge, 150ft. long, connecting the new Egremont Ferry landing-stage, Liverpool, with the pier, was lifted into position on the 20th inst., by the Mersey Dock Board's giant floating crane "Mammoth," which can lift up to nearly 200 tons. The whole operation of lifting the bridge and placing it in position was done in half an hour.

THE new Soviet steamer "Gruzia" has arrived at Odessa and will be placed on the rapid Odessa–Batum service. The double journey—outward and return—will now, says the *British-Russian Gazette*, be possible in five days instead of the previous twelve days. The carrying capacity of the "Gruzia" is 2700, and accommodation is provided for 1000 passengers.

A RECENT discovery of oil is said to have been made in the Pietersburg district of South Africa, and still more lately there comes news of a "Paraffin Syndicate" that has been investigating in the vicinity of Dannhauser, in Natal. As a correspondent of the *Star* says, "Dannhauser is already recognised as the centre of the Natal coalfields, and now, with the prospects of oil, the town is likely to be one of Natal's busiest mining centres."

CANADA is at present producing zinc at the rate of 96,000 tons per annum, and a greatly increased production of this metal is in sight, according to a bulletin issued by the Dominion Department of Mines. The present rate of 96,000 tons compares with a production of 93,000 tons last year, of which the province of British Columbia produced 85,000 tons, chiefly from the Sullivan mine, and Quebec, 11,000 tons, almost all from the Tetreault mine.

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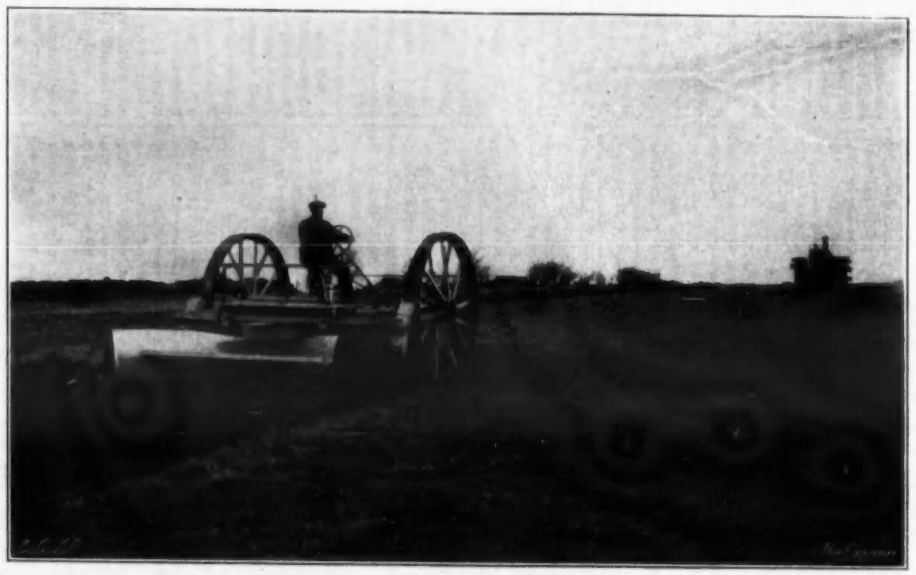

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The Metallurgist.

THE JUNE NUMBER OF THE MONTHLY METALLURGICAL SUPPLEMENT TO "THE ENGINEER" ACCOMPANIES THIS ISSUE.

DEATH.

ON June 22nd, CLAUDE W. HILL, M. Inst. C.E., M.I.E.E., M.I. Min. E., of 23, Old Queen-street, Westminster, London, S.W. 1.

THE ENGINEER.

JUNE 28, 1929.

Nineteenth Century Research.

IN recent years the Institution of Mechanical Engineers has adopted the wise course of having only one or two papers at its Summer Meetings. These papers have generally dealt with local industries and local interests, and have thereby suited the occasion. This year a slight departure was made from that practice. There was, indeed, only one paper, but instead of dealing with Manchester—where the meeting was held—the author took as his subject the famous researches which have been carried out in that city. Not every city has such a splendid record as Manchester. It is a record of which it has every reason to be proud, a record which it was fully justified in laying before that Institution which, as much, if not more, than any other, is associated directly with the subjects of Manchester research, and, as far as later work is concerned, has contributed to its achievement. The paper, which we shall reprint almost in full, was written by Mr. R. W. Bailey, Research Engineer of the Metropolitan-Vickers Company. He attacked his subject with manifest sympathy, and we believe all who read his survey of the great researchers of the past, particularly Joule and Fairbairn and Osborne Reynolds, will agree that he has handled a difficult matter with as much skill as knowledge. For years to come those who seek a general summary of the work of these great masters will do well to turn to this contribution to the "Transactions" of the Institution.

In his conclusion Mr. Bailey raises a very interesting question. "It may appear," he says, "that during the past century the stage was occupied by a few men of outstanding genius who made notable advances in the science of engineering. Although time, by submerging the commonplace, sets in relief the contributions of lasting merit, the period was certainly characterised by a few men of remarkable achievement. We are too close to the contributions made during the present century to obtain a correct perspective of their value, and it would be invidious even if it were possible to make comparisons with the past. Life has become more strenuous, the demands upon thought more various, and the question may be raised whether present conditions encourage or permit the continued concentration upon a subject which characterised the major researches of last century." The first inclination is to agree with the doubt which the author's question arouses. But further consideration tends to dispel it. Even if we sift out from the enormous volume of research which is being carried on to-day, all which is obviously of merely secondary importance, is routine in character, or is—like so much of the work performed in the huge research factories of America—nothing more than the development of industrial inventions—if all these things are cut away, it is true that with the exception of the atomic researches being carried on by men like Rutherford, Eddington, Lodge, and Bragg, there is little or none in the field of engineering and its allied sciences which can be regarded as fundamental in the same sense that the research of Joule was. But that, we suggest, is not the fault of the time nor of the men, but the result of the fact that most, if not all, the primary laws of Nature, if we may venture to make such a distinction, have been established and research must therefore concern itself with the secondary effects of those laws. That view, we admit, may be ill-founded. Perhaps some such tremendous law as that of the conservation of energy, some law that will draw together all sorts of diverse phenomena into perfect and simple harmony, remains to be discovered. It may be that, just as in Joule's time, men, even the wisest, were so satisfied with the theories in existence that they were unable to appreciate the value of his observations, so now we may be hoodwinking ourselves, and some later philosopher may discover that we, even we of this century of wisdom, have been deceiving ourselves, and the truth is not in us. Even if there is such a possibility, and it would be arrogant to deny it, yet the fact remains that a great part of the fundamental work has already been done, and that the scientists of the present enjoy, in consequence, less opportunities than those of the past. Joule owes his fame to a great hypothesis—the transformation of energy. Having seized upon that idea and having secured some inkling of its truth, he went on and on until he had proved it up to the hilt. If any equivalent hypothesis should present itself to-day, we are convinced that there are men in this country capable of pursuing it to a splendid conclusion, despite the fact that life is "more strenuous," and the demands upon thought "more various." But great hypotheses spring from great imaginations. Whether the present conditions do less to encourage the imagination than those which prevailed in the middle of last century, is a difficult question to answer. But one may hazard the suggestion that the increase of knowledge, and particularly the extension of the fields of knowledge, does tend to hamper excursions of the fancy. The history of many, even if not all, the great fundamental truths shows that they had their origin in the pursuit of hypotheses which were deemed in their day to be the dreams of madmen. To-day such dreamers are hemmed in on every side. Let anyone show but the slightest sign of that kind of madness, and he is clapped at once into a strait-jacket composed of all the acknowledged laws of Nature, and the opinions of a thousand philosophers. In this respect, and it may be precisely what Mr. Bailey had in mind, we are inclined to think that the facts are on his side. There is no dearth of speculative philosophy, but it is less common now in the affairs of engineers than it was three-score years ago.

The relative merits of researches in pure science and researches conducted with an immediate industrial purpose in view will always form a subject of debate. The former is greater in that it establishes great generalisations, whilst the latter particularises, and may have little value outside the special problems with which it is concerned. But the latter is greater in that it provides the world with something of immediate use to it. Is Joule's equivalent as important to the world as Swan's incandescent lamp? That is a question very difficult to answer. There may remain other laws as great as Joule's still unknown, and we can get on without the knowledge of them better than we could without tinned salmon. Einstein's theories, for example, are likely to exert much less influence

upon the lives and manners of the present and future generation than television. The greatest laws explain phenomenon; they enable us to handle them with safety and certainty for our convenience and comforts. They owe their greatness to their breadth. But we cannot do without material researches as well, researches, for example, like Faraday's, through which new phenomena are discovered and brought under control, or—to come back to Manchester—the researches of Fairbairn into the strength of materials. Most of the later researches of that city have been of the latter kind. Their object has been to discover the scientific basis of familiar phenomena in common use with a view to their improvement. The Cutting Tools Research is a very typical example, or the investigations by insurance societies into the strength of boilers. The research work that is being carried out under Mr. Bailey's own direction is also of direct benefit to humanity. In engineering, research for the time being has swung round from the abstract to the concrete, but a later age, able to look back upon this and see it in its true proportions, able, as Mr. Bailey has it, "to obtain a correct perspective of their value," may place researches carried out under the pressure of "economic necessity" on a different, but not a lower plane than researches in pure science.

The Safety of Transport.

THE recent accident to an Imperial Airways machine, involving the loss of seven lives, has called renewed public attention to the safety of civil aviation. The alarmists and the apologists have each expressed their views on the subject. Both sides, we feel assured, have been responsible for a considerable and regrettable volume of loose opinion and for numerous statements which will not bear close examination. A knowledge of what has been done on the technical side of aeronautics during the past few years enables us to assert without hesitation that quite definitely the safety of flight is now greater than it was. If, however, we are asked to demonstrate this truth by analysing the accident statistics, we must make the admission that we are unable to do so. It is impossible to deduce a proof from the accident figures for one major and one minor reason. The lesser consideration is the fact that civil aviation has had a life of only ten years, a period which is too short to be divided into sections for the purposes of comparison. The greater consideration is the fact—a fact which, we find, is not universally appreciated—that there is in common use no simple obvious standard, free from an arbitrary basis, whereby the safety of flight—or, indeed, of any other form of transport—may be assessed. With the passage of time the lesser consideration will become of decreasing weight. The greater will remain of undiminished significance until some rational basis of expressing safety is established. For the railways we have a hundred years of accident statistics to draw upon, a period long enough to be subjected to analysis. Even yet, however, we lack a non-arbitrary standard whereby to judge the safety of railway travel and how it is improving, just as we are without one for travel by air or by sea or by road.

The common method of analysing accident statistics for the purpose of studying the safety of any form of transport is quite arbitrary. It consists of determining the number of accidents, or the number of casualties to passengers, occurring in a year or other unit of time. The arbitrariness resides in the introduction of the time factor. Were the occurrence of accidents in any way related to the position of the earth in its annual course round the sun, there would be a certain amount of reason for taking the year as a basis of comparison. But as astrology is no longer an accredited science, we are equally justified in taking a month, six months, two years or a decade as our time basis. According to the precise time basis selected, so will the results of our analysis of the accident figures be presented in a different light. Extreme, but not impossible conditions can be named in which one and the same set of accident figures can be made to imply an increasing, a decreasing, or a constant safety factor according to the choice made for the time basis. During 1928 there was an exceptional number of accidents on British railways. It cannot be maintained that the high yearly rate reflected an actual diminution of the safety of railway travel in this country. Still less can it be maintained that the safety factor was at a much lower level during the second six months, the period covering the bulk of the accidents, than during the first six months. If, however, we reject six months or a year as too short a time basis, what period shall we take? Clearly, there is no period that will free our standard of arbitrariness. Another, and less usual, method of analysing accident returns for the purpose of studying safety in transport is to determine the intervals occurring between successive mishaps. The interval may either be an interval of time, of distance travelled—that is, machine or train miles—of passengers carried or of passenger miles. If the services are regular, if the number of passengers carried per day is constant, and if the capacity of the machines, vehicles, ships, or coaches is not altered, the safety factor determined on this basis will not be dependent upon the precise interpretation of the interval. But if these things are not so—and in commercial aviation particularly they certainly are not—the safety factor will vary widely accordingly as we interpret interval as an interval of time, miles, passengers, &c. To select any one interpretation and exclude the others, immediately introduces an arbitrary element into our standard, for all interpretations are equally reasonable. Even although there were only one possible interpretation, the absolute interval between accidents would tell us nothing. There were very short intervals—of time—between the railway accidents in the closing months of 1928. Common sense and technical knowledge of the working of our railways alike require us to reject the shortness of these intervals as a sign of decreased safety. We feel that we ought to average the intervals over some period of time. If we do so, however, we shall introduce a second arbitrary element into our standard of safety, namely, an arbitrary time basis, as in the case of the standard previously discussed. It is no evidence of decreased safety if we find that the average interval—of time—between accidents in 1928 was less than in 1927. It might well be that the average interval taken over the two years 1928 and 1927 was longer than that in the two years 1926 and 1925. Which criterion gives a true measure of the safety during 1928?

It is evident that the introduction of the time factor is at the root of our difficulty in devising a satisfactory non-arbitrary measure of safety in transport. Is there any rational way in which it can be excluded from consideration? One method of doing so may be suggested. We may take as the measure of safety the progressive average interval between accidents. Defining "interval," for the sake of example, as the number of machine—or train—miles run between accidents, let us suppose that accidents occur after 6, 12, 19, 27, 36, 46, 57 thousand miles have been run. The accidents are occurring at uniformly increasing intervals, a fact which without analysis may be taken as sound evidence that the safety is increasing. The average of the first two intervals is 6·5, of the first three 7·0, of the first four 7·5, of the first five 8·0, and so on. The progressive average shows a uniform increase, and is therefore in accordance with our instinctive deduction. It will be found to be equally in accordance with our *a priori* impressions for a series of figures representing the occurrence of accidents at uniformly equal and at uniformly decreasing intervals. In practical life, accidents occur at erratic intervals. How are we to put a bad patch, such as that which occurred on our railways towards the end of last year, into the proper place which instinct tells us it should occupy, but which we cannot quite assign by the usual arbitrary methods? It will be found that the progressive average process causes a bad patch to lower the safety figure by a small and reasonable amount if the preceding figures have indicated a good degree of safety. The method will also be found to be in agreement with what we feel to be right in that a bad run of accidents at short intervals in the early days of a transportation system has a graver effect on the safety figure than a similar bad run encountered later on in the life of the undertaking. Had last year's accidents occurred in the early days of our railway history, we would properly have had to regard them as reflecting very seriously on the safety of transport by rail. Coming as they did after a hundred years of railway travel, their gravity from the point of view of the assessment of safety is, as it should be, reduced. It is too large a task to endeavour to calculate the progressive average intervals between accidents on our railways. It is not too late to do so for commercial aviation. The Air Ministry almost certainly possesses the figures required for the purpose. Without them we feel that none of the statistics so far published by the Ministry enable us to form a fair and rational estimate of the progress which civil aviation is undoubtedly making towards increased safety.

Institution of Mechanical Engineers.

No. I.

SUMMER MEETING.

THE summer meeting of the Institution of Mechanical Engineers, which opened in Manchester, on Tuesday last and comes to an end to-day—Friday—is the largest by far in the whole life of the Institution, the number of those taking part being estimated at over nine hundred. On the opening day the weather was exceptionally fine without being oppressively hot, and the many visits to works and other places of interest in the neighbourhood, which occupied all the afternoon, were conducted under very pleasant conditions.

The general offices of the Institution are in the School of Technology, where the members were received by the Lord Mayor in the splendid examination hall. The Lord Mayor (Colonel G. Westcott), in addressing the meeting, said that it was commonly supposed that Manchester was exclusively interested in cotton. As a matter of fact, the money involved in engineering activities slightly exceeded that in cotton. Manchester was the birthplace and home of many distinguished engineers, and it was very fitting that the Institution should visit it. On behalf of the city he offered a very hearty welcome to the members.

Mr. Daniel Adamson (President), thanking the Lord Mayor for the welcome that he had extended to the Institution, referred to the fact that the first meetings of the Institution were held either in the house of Mr. Beyer, part founder of Beyer, Peacock and Co., or in that of Mr. McConnel, the famous locomotive superintendent of the London and North-Western Railway, both of whom were on its first Council. Referring to the prominent part which Sir Joseph Whitworth—on the site of whose works the College of Technology now stands—played in the development of engineering, Mr. Adamson presented to the Lord Mayor a copy of the Whitworth Book and a cheque for £25 from the Whitworth Society, which was to be used for the presentation of consolation prizes to Manchester students who just failed to gain Whitworth awards.

Mr. E. F. S. Lang (Beyer, Peacock) then presented to the Institution a portrait of Charles Beyer, which had been bequeathed to him by his father.

Mr. Bailey (Metropolitan-Vickers) then read in abstract a paper entitled "The Contribution of Manchester Researches to Mechanical Science." This paper will be reprinted in full in our pages.

The President called for a vote of thanks to the author and invited Dr. Hele-Shaw to second it. In his speech Dr. Hele-Shaw alluded to the very important part played by Sir Joseph Whitworth, and, like all subsequent speakers, laid stress upon the value of research. Then followed a discussion, in which Messrs. A. P. M. Fleming, Francis Hodgkinson, A. E. Ingham, Professor Gibson, E. G. Herbert, and A. Saxon took part. The tenour of all the speeches was the same, but Mr. Fleming, alluding to the historical value of the paper, suggested that professors should "compel" their students to study the work of great pioneer investigators by examinations on their writings, and Mr. Hodgkinson referred to the "human interest" which characterised the paper. If we may do so, we should like to express the hope that by appeal to that human interest professors will lead—rather than "compel"—students to take an interest in the historical side of science and industry.

After the meeting the members took luncheon at the Midland Hotel and then split up into various parties to pay visits to works and other places of interest in and around Manchester.

Amongst the visits paid on Wednesday, special mention must be made of that to the works of the Metropolitan-Vickers Electrical Company, Ltd., Trafford Park, as it was by far the most largely attended, over four hundred persons sitting down to luncheon, and was honoured by the presence of the Lord Mayor and Lady Mayoress. The inspection of the works took place in the morning, and the visitors were much impressed by the large volume of work in hand in all departments. The arrangements were excellent, and if the schedule did not permit everyone to see, and hear, from the well-informed guides, all that he desired, the compulsory time schedule was alone to blame. At the luncheon which the company offered to the visitors, Sir Philip Nash took the chair. In the course of a little speech of welcome, he mentioned that the company worked for no less than twenty-two different countries, that it received from twenty-five thousand to thirty thousand orders per year, and that the average value in pounds sterling for plant orders was £115. The President, Mr. Adamson, responded on behalf of the Institution.

A banquet was held on Wednesday evening in the Midland Hotel, at which the Lord Mayor and Lord Colwyn were the principal guests. The toasts were very wisely cut down to two, the first, "Manchester," being proposed by Colonel Kitson Clark, in his usual light but scholarly vein. To it the Lord Mayor responded, and in doing so laid particular stress upon the influence of the Ship Canal and the important part that the President's father had played in its inception. Lord Colwyn, in a delightful rhetorical speech which ranged over a large number of subjects, proposed the toast of "The Institution," which was

suitably acknowledged by the President, who took the opportunity to express the pleasure that it gave the Institution to see so many ladies present. An informal reply by General Mowatt on behalf of the ladies brought a very pleasant evening to an end.

VISITS TO WORKS.

On Tuesday afternoon organised visits were paid to a number of works in the Manchester area, among which were those of Joseph Adamson and Co., Beyer, Peacock and Co., Mather and Platt, and Henry Simon. We give below some notes on these establishments.

JOSEPH ADAMSON AND CO., HYDE.

These works were established in 1874 by the late Mr. Joseph Adamson, in partnership with Mr. Henry Booth, who retired in 1887, and are carried on to-day by Mr. Daniel Adamson, the eldest son of the founder of the business, assisted by his two sons Mr. G. R. Adamson and Mr. J. Adamson. Originally the activities of the firm were devoted to the manufacture of steam boilers, but the scope of the business was enlarged, first in 1883 by the erection of a new shop to specialise in hydraulic press work, and, secondly, in 1894 by the construction of one of the first three-motor electric cranes to be built in this country, the success of which resulted in the placing of further orders and the establishment of the firm as crane makers.

The works are divided into nine bays. Nos. 1 and 2 contain the hydraulic presses and their dies, of which there are to-day upwards of 1100 tons ranging in size from 2ft. to 12ft. 6in. diameter. The largest of the three flanging presses will admit plates 13ft. 4in. diameter in the flat. No. 3 bay is the smithy which contains an overhung press for sectional flanging, as well as the machinery for fire welding and flanging boiler flues, bending and welding angle rings, &c. A part of this bay is now given up to welding by the electric and oxy-acetylene processes. No. 4 bay is the plate shop, containing plate edge planer, bending rolls, multi-spindle horizontal and vertical drilling machines, two large vertical boring and turning mills, and heavy duty radial drills. No. 5 bay contains the pattern shop and the blacksmiths' shop. No. 6 bay is the boiler shop. The riveting tower, 60ft. high, contains three fixed riveters and two electric hoists. Nos. 7 and 8 bays, with the gallery over the latter, form the crane erecting and machine and electric shops. A feature of the former is the testing pit over which all cranes are erected for testing under any desired load or overload up to 100 tons.

BEYER, PEACOCK AND CO., LTD., GORTON.

In the present year these works celebrate three-quarters of a century of locomotive building for all parts of the world, having been founded in 1854 by Mr. Charles F. Beyer and Mr. Richard Peacock. They cover a total area of 23 acres, of which between 17 and 18 acres are roofed shops, and, when working up to full capacity, find employment for 3000 men.

The general offices form a large two-storey building, the ground floor being devoted to the commercial departments and the upper floor to the designing and drawing-offices. A new building was equipped five years ago to house the cost accounting and statistical services, and is provided with modern electrical tabulating and other machinery.

The iron and steel foundries are situated in one building. The equipment of the steel foundry includes two 10-ton acid Siemens-Martin furnaces. The installation of an electric furnace melting plant is in hand. The annealing furnaces are gas-fired from the plant used in connection with the melting furnaces. There is also a brass foundry capable of producing individual castings as large as the heaviest axle-boxes.

The forge is equipped with five steam hammers, including one of 7½ tons, capable of dealing with the largest sizes of steel blooms required in locomotive work. Two hammers are served by gas-fired furnaces and the remaining three by oil-fired furnaces. The department also includes annealing and case-hardening furnaces.

An outstanding feature of the firm's policy of modernisation is to be seen in the new boiler department, which came into operation in 1925. This department consists of three longitudinal bays and a riveting bay. The main or boiler building and mounting bay is fitted with two crane gantries of 62ft. and 59ft. span respectively, one above the other. The upper accommodates travelling cranes of 50 tons capacity, and the lower one carries cranes of 10 and 5 tons capacity. The middle bay has a single gantry of 50ft. span for cranes of 20 and 10 tons capacity. The third bay has also a single gantry, but of 45ft. span and carrying cranes of 10 and 5 tons capacity. These three gantries lead into a high transverse end bay equipped with cranes, having remote control, of sufficient range of lift for dealing with the longest boiler shells. In this transverse bay are situated the deep-leg riveting machines.

The framing department has a span of 75ft., and is 305ft. long. It has a single gantry carrying cranes of 6 and 20 tons capacity, the former having remote control. In this department are machines for handling not only the plate frame, which is common to British locomotive practice, but also the bar type of frame, usually associated with American locomotives and used in a considerable number of Garratt locomotives recently designed and constructed at Gorton Foundry.

The erecting department is arranged so that the locomotive frames and stays are built on either side of a central track. The frames, after the cylinders, boiler, and other parts have been fitted, are lifted by overhead cranes and lowered on to the wheels standing on the central track, which has a pit for its whole length. The fittings are then mounted in place, the engine completed and passed straight out into a steaming shed, and finally to the trial track for inspection, under actual conditions of working.

Gorton Foundry was one of the pioneers in the use of electric driving, as in 1897 it was fully equipped with its own electric generating plant. In 1906, the advantages to be derived by using power from the Corporation were realised, and the works power station was changed completely. Current is now taken from the Manchester Corporation at 6500 volts. A large portion is transformed to alternating current at 220 volts, whilst the remainder is converted to direct current for cranes and lighting purposes.

An example of the progressive policy of the firm is to be seen in the method of internal transport. The works are equipped with a number of Millars' truck tractors, Lister auto-trucks, and a Ransome and Rapier mobile petrol-electric crane for handling the wide variety of component parts. These vehicles work to a time-table, and travel on concrete roads throughout the works.

The visitors had the pleasure of seeing the Ljüngstrom steam turbine locomotive under steam and of examining a Garratt locomotive, which is the largest locomotive ever constructed outside of America.

MATHER AND PLATT, LTD., PARK WORKS, NEWTON HEATH.

The first works were established almost a hundred years ago in Salford by the great-grandfather of the present chairman. By 1900 the buildings had covered the whole of the site avaliable, and it was decided to secure a new site outside the town for the erection of large modern works. An ideal one was found at Newton Heath. On it a modern engineering works has been built, and extended continually in accordance with an ordered scheme of development. Building operations were commenced in 1900 with the erection of the administration building of two stories, surmounted by the tower, and the adjoining machine shop, which had originally been the machinery annexe of the Paris Exhibition of 1900. This was purchased *en bloc*, taken to pieces in Paris, shipped in a steamer specially chartered, and delivered at the Manchester Ship Canal docks. The shop is 376ft. long and 130ft. wide. It is used for the manufacture of valves, &c., and as the general stamping department for the whole of the works. It also contains two large general stores.

Important additions to the new works were made in 1903, 1905, and 1909, when increased accomomdation was provided for the electrical engineering department by the construction of two more machine shops, each 376ft. long by 40ft. wide. In 1909 it was decided to make provision for the removal of all the remaining departments from the old works in Salford, and in 1910 seven more shops, each 376ft. long, but with bays 52ft. and 42ft. wide respectively, were constructed.

In 1913 pressure of business made further extensions imperative, and accordingly a new wing of four bays, 439ft. long by 161ft. wide, was commenced and completed just before the outbreak of the war. In 1920 demands for increased production necessitated still further extensions, and fourteen of the bays, of a total width of 615ft., were lengthened by 178ft.

After trying various systems of truck haulage in the works, the use of battery electric locomotives was found to give the best results, but to economise battery current, the electric locomotives are also arranged to collect from overhead trolley wires over the section between the works and the main line. The general illumination of the shops is carried out by means of high-power, gas-filled, metallic filament lamps, arranged above the cranes, and for the individual lighting of machines, where extra light is required, smaller electric lamps are used.

The firm early realised the benefits which would accrue through the education of apprentices, and a works school was established, which all the younger apprentices attend during working hours. The school is one of the first recognised by the Board of Education under the new Education Act.

The works now cover about 20 acres of the land available, and there is still ample room for extension. The power for the works is taken from the Manchester Corporation electric supply mains, and is transformed by means of rotary converters and motor generators.

Special provisions have been made for testing all products, and all dynamos, motors, and pumps are carefuly tested for output and efficiency before delivery. Water for manufacturing, fire protection, and other purposes is obtained from a large reservoir, into which all the rain water from the roofs, &c., is drained. From this reservoir the water is delivered by means of a vertical-spindle electrically driven turbine pump through a mechanical pressure filter into a large elevated tank placed in the tower, whereby a constant pressure is maintained in the distributing mains. For drinking and all other purposes than manufacturing, water is taken from the Corporation mains.

HENRY SIMON, LTD., CHEADLE HEATH.

The firm was founded fifty years ago, and has specialised in the manufacture of grain-cleaning and flour-milling machinery. In recent years the manufacture of conveying plant has been undertaken and this branch of work now occupies an important place. The development of the pneumatic system of discharging and conveying coal, grain, oxides, &c., in bulk has also received considerable attention. Before the erection of the new factory at Cheadle Heath in 1926 there were two workshops, respectively at Stalybridge and Bredbury, which, though able to deal with a large amount of work, were not arranged to the best advantage. The present works, which are situated in pleasant surroundings, occupy 6 acres of the site of 23 acres, and are laid out on one floor and under one roof to facilitate communication between various sections. The separate sections are:—(*a*) Joiners' shop, comprising machinery work, bench work, and assembly; (*b*) sheet metal department, comprising black iron sheeting and tinsmiths' shops; (*c*) machine shop; (*d*) fitting and erecting shops; (*e*) paint shop and packing department. A feature of the organisation of the works is the stores which extend along the whole of one side of the buildings and to which the different departments are arranged at right angles, so that the products of a department can be passed into store and retained till required, by which means internal transport is reduced to a minimum.

Among the works visited on Wednesday were those of Leyland Motors and the Metropolitan-Vickers Electrical Company.

LEYLAND MOTORS, LTD., LEYLAND AND CHORLEY

The company has been engaged in the manufacture of commercial vehicles since 1895, though its history can be traced to a blacksmith's shop as early as 1885, when Mr. James Sumner conceived the idea of utilising steam power for driving wagons. Though his first experiments were carried out with considerable success, it was not until after the passing of the Locomotives on Highways Act of 1896 that his vehicles attracted the attention of Mr. Henry Spurrier, the father of the present managing director, who was sufficiently interested to form a company, styled the Lancashire Steam Motor Company, in 1896. The partners of this company were Mr. Henry Spurrier, sen., Mr. Henry Spurrier (present managing director of Leyland Motors), Mr. Arthur Spurrier, and Mr. James Sumner. This company, the name of which was afterwards changed to Leyland Motors, was formed for the manufacture of steam wagons exclusively. In 1897 the first steam wagon was put on the road and secured the first prize at the trials organised by the Royal Agricultural Society. The company repeated this success in the following year, as well as obtaining a £100 prize as a result of the famous trials held by the Liverpool Self-Propelled Traffic Association in 1898. Similar successes followed, and in 1902 the Herbert-street works were found to be inadequate, and the Lancashire Steam Motor Company was, therefore, registered as a private company, land was purchased, and building begun on the present site.

Up to 1904 its activities were confined to the manufacture of steam wagons, and although business in this type of vehicle was continuously expanding, the company did not overlook the possibilities of the petrol internal combustion engine, and as early as 1904 the design of a petrol vehicle was completed, and an experimental machine was produced at the Herbert-street works at the close of that year. From 1914 onwards, the company continued to expand rapidly, and in the two years following the outbreak of war, the head offices were completed, Chorley Works opened, and further land in Leyland purchased for the erection of the company's steel foundry and coach-building shops, until the company's Lancashire properties extended over 160 acres.

The present-day Leyland products are petrol-driven commercial vehicles of all types, including passenger vehicles, goods vehicles, and fire-engines. These vehicles are all manufactured at Leyland, though certain of the components of the heavier goods models are made at the Chorley branch works, where also all fire-engine products are manufactured.

The main works are concentrated around the original site and consist of two blocks—North and South Works—divided by the principal street through the town. The Farington Steel Foundry is situated about a mile from the main works. The North Works are devoted to the manufacture of the chassis. The South Works buildings are used primarily for coach-work. The non-ferrous metals foundry is also situated in the South Works. The steel foundry is situated about a mile from the main works, and has a floor area of about 10,000 square yards. It is divided into two distinct sections for the production of steel and iron castings. Two electric furnaces of 4 and 3 tons capacity are used, and are supplied with energy from the firm's power plant, which also supplies a large amount of lighting for the village of Leyland. Attached to the foundry is a machine shop where castings are machined, so as to enable cylinders, axle

castings, and similar parts to be dispatched to the main store ready for assembly.

One of the features of the organisation is the institution of an independent service stores, which is established in a separate building near the South Works. This store is open day and night, and carries a maximum and minimum stock of parts for all types of vehicles. It has its own dispatch department, and transport vehicles.

THE METROPOLITAN-VICKERS ELECTRICAL COMPANY, LTD., TRAFFORD PARK.

Since 1901, when the dispatch of completed goods commenced from the company's works at Trafford Park, the aggregate capacity of apparatus manufactured has totalled well over 30,000,000 horse-power. The company has also a factory at Sheffield, and subsidiary companies manufacturing insulating materials, lamps, fittings, and domestic appliances. The main works at Trafford Park have a floor area which recent extensions have increased to 1½ million square feet. The number of workpeople and staff in this factory at the present time is over 10,000 and the total number of the firm's employees is over 15,000.

The buildings run north and south. The northern end constitutes the frontage and provides accommodation for the administration, technical, selling, and other staffs. The southern end borders on the Bridgewater Canal. Materials are delivered to the southern end of the workshops over the railway tracks which intersect each building. The finished products are picked up at the northern end by the service railway for dispatch to their destination. The total weight of incoming material and outgoing finished products exceeds 500 tons per day.

The factory buildings are designed to give continuous central aisles with flanking galleries. In the main shops the aisles are of considerable size, each being 900ft. in length by 90ft. wide, the total overall width of the shop being 440ft. and the height 80ft. to the ridge of the roof. The railway tracks pass down the centres of the aisles to feed or draw from either side. Each of the main aisles is spanned by three or four 50-ton electric cranes, having full command of both the width and length of the shop. The overhead handling equipment is supplemented by a number of jib cranes disposed in a row along either side of the aisle, to swing the material to and from the machines and in and out of the detail assembly bays or stores under the side galleries. This arrangement leaves the whole of the central space of the well free for manufacture and assembly of the largest units. One advantage of the lay-out is the flood of natural illumination from the glass roof over the whole area of the main floor. The galleries on either side of the aisles, which are continued round the latter at each end, as well as the spaces beneath, are allocated to the manufacture of the lighter products, such as switchgear, control gear, small motors, &c., and components required in the manufacture of the larger machines.

In the main shop one aisle is devoted to heavy mechanical units, *e.g.*, turbines, condensers, and their auxiliaries, with a section set apart for the manufacture of special gearing used in connection with marine turbines. The second aisle is reserved exclusively for the manufacture, assembly, and testing of the larger electrical units, such as heavy duty motors, rotary converters, motor generators and alternators. In an adjoining aisle is the recently reorganised motor test-bed, which is claimed to be the largest and most completely equipped in this country. The galleries are sectionalised in a similar manner, each section being devoted to the production of one class of article.

On the eastern side of the main avenue, which runs north and south through the works and opposite to the main building, is the transformer department. Next to the transformer shop, also on the east side of the main avenue, is the foundry. It is equipped with the latest types of moulding machinery, and all the castings used in the works, excepting those of steel, are made in it. The plant is capable of dealing with large-size castings up to 60 tons in one piece required for turbines, condensers, bed-plates, stators, &c.

An important works extension of special interest is a large building which has recently been erected to the west of the main works. It is 420ft. long and 220ft. wide and provision has been made for extensions which may more than double this size. It is equipped for the assembly and testing of the largest switchgear units, of both the metal-clad and outdoor types, required for the British "grid" and other super-power schemes in connection with which the company has large contracts in hand.

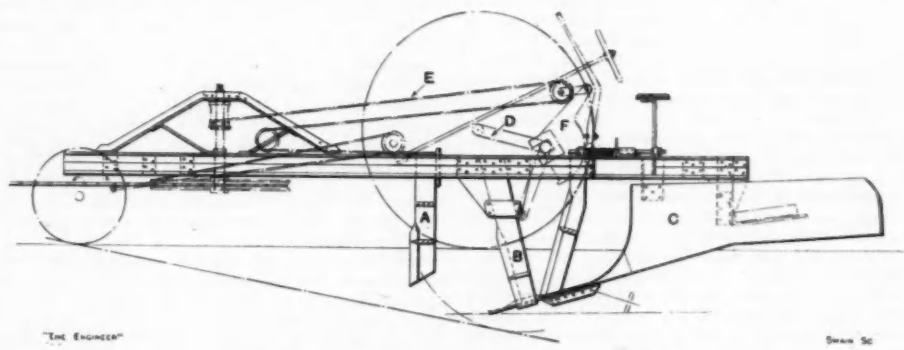
All plant in the works is electrically driven, and under normal working conditions the demand exceeds 17,500,000 units per annum.

The research department, which is one of the notable industrial research organisations in this country, is accommodated in a group of buildings situated to the south of the works. A two-storey building, forming the frontage of the group, houses the administrative staff and the intelligence section, including the library. Immediately behind are two single-storey laboratories, each 100ft. long by 70ft. wide. One is occupied by the electrical and magnetic group and the chemical and physics sections, the other contains the mechanical, metallurgical, and materials and process sections. Further back stands the large building which houses the high-voltage laboratory and a number of smaller laboratories equipped for a variety of special work. The equipment of the laboratories includes many items of interest. The mechanical and metallurgical laboratory, in addition to a range of modern testing machines, has a special machine for measuring the creep of metals, under controlled tension and temperature conditions, to within one-millionth of an inch per inch of test specimen. There is also apparatus for the analysis of vibration and its effect in producing fatigue in metals, and Professor E. G. Coker's apparatus for the optical determination of stress in strained members. Of considerable interest is the precision rolling mill used for rolling tungsten, molybdenum and zirconium, and for the preparation of very fine metallic foils, such as copper and nickel, required for experimental work. A considerable amount of work is being done with the mill on a commercial basis for the preparation of molybdenum sheets up to 6in. in width and 3ft. 6in. in length and of 1/400in. in thickness. The apparatus in the high-voltage laboratory includes two half-million volt transformers built by the company and arranged for use either separately or in cascade to give 1,000,000 volts. There is also a million-volt surge testing equipment to give steep-wave-front, high-frequency impulses in investigations on the effects of lightning on high-voltage apparatus. For tests upon outdoor type apparatus, an arrangement is provided by means of which artificial rain of any required characteristics can be produced over the test area. Recent additions to the department include an acoustic laboratory for the investigation of the noise emitted by machinery with a view to its reduction, and a photometric tunnel for the study of illumination problems. The organisation of the department is such that in addition to dealing with the problems of current manufacturing work, it is able to undertake all the stages of development required to bring a discovery in pure science to a commercial manufacturing proposition.

(To be continued.)

A Ditch-making Machine.

WE recently had an opportunity of inspecting at work a new machine which has been designed by John Fowler and Co. (Leeds), Ltd., of Leeds, for the cutting of irrigation or drainage ditches in a single operation. This machine, which is illustrated in the accompanying drawing and in the half-tone engravings on page 708, is used in conjunction with the powerful steam winding engine which this firm has developed for stump-pulling and forest clearing work. It is capable of making a ditch 2ft. deep by either 3ft. or 6ft. 6in. wide at the top, with sloping sides and a bottom width of about a foot, in a single operation. The speed of advance is such that from 3 to 4 miles of ditch can be completed in a day, and the crew only amounts to five men—in some cases three men are sufficient. The saving which can be effected by using this machine will be realised when it is borne in mind that over 500 men would be required if the same amount of work was done by hand. The makers do not suggest that the ditcher is likely to have much vogue in this country, where the holdings are comparatively small; but for overseas work, where long stretches of ditch have to be made, they claim that it is the most economic method possible. The cost of excavation with the Fowler machine works out, we understand, at just over 1d. per cubic yard, as compared with 5¾d. if a drag line excavator is used, and about 7d. for an elevating grader.



ARRANGEMENT OF DITCH-MAKING MECHANISM

The ditching machine might be described as an unusually large and powerful double-breasted plough, which, in one operation, cuts out the shape of the ditch, removes the spoil, and dumps it clear of the sides of the ditch with a berm about a foot wide to check the earth being washed back into the bottom. Such an operation naturally requires a very powerful tractive effort, and that provided by the engine may amount to as much as 24 tons, but it will probably be best to explain the construction of the ditcher itself before going on to the winding engine.

The ditcher, as will be seen from the drawing, has a very substantial framing of channel section, from which depend the actual ditching implements, comprising the knife A that decides the centre line, the bow-shaped knife B which defines the contour of the finished ditch, and the pair of ploughshares or boards C for lifting the spoil out of the ditch and dumping it on the land alongside. The whole machine is carried by three wheels, one for steering in the front and two on a cranked axle, approximately over the digging tools.

The cranked style of axle is adopted, as is so often the case with agricultural implements, as a means of lifting the cutters out of the ground when a cut has been finished, and the machine must be moved to another place for further operations. In the normal working position, the throw of this crank lies in an approximately horizontal direction, but if it is required to raise the cutters, the crank is brought into a vertical position and correspondingly raises the frame of the machine.

In normal working the change is effected by the two-fold purchase E shown in the drawing, which is attached to the forging F fixed on the axle crank. On the occasion of our visit the ropes for this purpose had not been rove, as our advent was more or less unexpected, and there were only two men in attendance on the plant. So we suggested that in every-day working such circumstances might arise again, and asked if the engine could then release the ditcher. The engine man said that he thought it could be done, and hitched the single part of his hauling rope to the horn of the piece F and successfully lifted the machine right out of the cut. The effort necessary for this manœuvre may be gauged from a consideration of the fact that it was not only necessary to pull the ditcher forward through the ground as it rose out of the cut, but there was also the weight of the machine and the soil within the ploughs to raise through a distance of slightly over 2ft. The plant, however, met these requirements without any great difficulty.

And it is here that we come to another exemplification of the sturdiness of the two machines—for the ditcher and the winder can hardly be considered apart. The procedure is that the winding engine proceeds ahead of the line for a distance of about a hundred yards. It is there scotched and hauls up the ditcher. The engine then goes forward and the process is repeated. It will be obvious that to develop a pull of some 24 tons the wheels of the winder must be very thoroughly scotched, and one of our engravings shows the system adopted, which hardly needs further elaboration.

It is the intention of the makers that this rig should be used with a two-fold purchase on the ditcher, so that the hauling rope, after passing over the large pulley in the front of the ditcher—shown in the line drawing—returns to be anchored on the offside of the winder. In this way a comparatively balanced pull is put on the two sides of the winding engine and the two scotches share the work of holding it. We did not, however, feel justified in asking two men to reeve a length of 100 yards of 1¼in. steel cable for a double purchase, and were content to see what happened with a single part pull, although it was very one-sided. The machine, nevertheless, did succeed in all the tests to which we put it, although the scotch on the near side buried itself to some extent. And this was in pulling the ditcher through a field of clayey shale, matted together with tough grasses that had not been disturbed for many years.

In connection with the stability of the winder, it should be noted that the winding drum is arranged rather differently from that of an ordinary tractor engine. The drum is loose on the back axle and is driven directly by the engine through a pinion gear having a ratio of about 5 to 1. It rotates in a clockwise direction, while the lead-off of the rope is from the bottom. As a consequence, there is no tendency for the front end of the engine to rear up if the pull on the rope becomes excessive. In other words, the back axle is only used as a convenient and substantial foundation for the winding drum, which has no direct connection with the travelling gear when winding.

The engine itself is rated at 80 I.H.P., but it is capable of developing as much as 120 I.H.P. for short periods, and runs at a speed of 170 revolutions per minute. It has travelling speeds of 1¾ and 4 miles per hour, and the hauling rope speeds are about ½ and 1 mile per hour.

IT is reported from New York that wireless tests have recently been begun between the liner "Leviathan" and the American Telegraph and Telephone Company's experimental station at Deal, New Jersey, with a view to establishing ultimately a regular telephone service between ships at sea and any home office in the United States. A regular service as regards the "Leviathan" is contemplated in the autumn.

MOUNTINGS forming part of a boiler and subject to the full working pressure should be of ample strength, especially when they have to withstand heavy bending stresses, as in the case of water gauge cocks. These may work stiffly, and therefore should always be easily accessible from positions free from danger if the glass breaks. Gauge cocks certainly should not be wrenched open with the help of a piece of iron pipe, as described in a recent boiler explosion report. The gauge broke off and the attendant was badly injured.

The Contribution of Manchester Researches to Mechanical Science.*

By R. W. BAILEY, Associate Member.

MANCHESTER'S long and notable contribution to mechanical science is a record of which the city has every reason to be proud. Engineering science was cradled in Manchester, and for upwards of a century, favoured by a succession of scientists and engineers of the highest genius, a continuity of research has been maintained which has not only provided the foundations but also much of the structure of organised technical knowledge constituting the mechanical science of to-day.

In all branches of engineering invention, construction, and manufacture, Manchester has always occupied a leading position. Such names as Fairbairn, Nasmyth, Roberts, and Whitworth are a sufficient testimony to the accuracy of this statement, if any were needed. Its position in the development of engineering science is no less remarkable. Whereas, however, engineering construction and manufacture readily become known and identified with a place or area, the universal character of scientific knowledge, its unobtrusiveness, and its association with persons, frequently obscure altogether the place where a discovery or advance has been made. The President and the Committee of the North-Western Branch considered, therefore, that it would be appropriate and of interest if a paper were presented at this meeting giving an outline of Manchester's contribution to mechanical science as represented by its published research.

Although a striking continuity is to be found in many of the subjects explored, Manchester researches may be regarded as falling broadly in two periods, the first represented by Dalton, Fairbairn, Joule, and their contemporaries, and the second, extending down to the present time, magnificently opened by Osborne Reynolds. The first period was characterised by individual effort and a wealth of experimental work truly astonishing when viewed at this distance; the second by the support of scientific institutions and technical bodies and, naturally, by a much greater use of analytical methods. The coming growth of analytical methods was foreseen by Joule, who wrote in reference to his remarkable experimental verification of Sir William Thomson's prediction of the thermoelastic properties of metals: "To him specially do we owe the important advance which has recently made a new era in the history of science when the famous philosophical system of Bacon will be to a certain extent superseded, and when instead of arriving at a discovery by induction from experiment we shall obtain our largest accession of new facts by reasoning deductively from fundamental principles."

John Dalton (1766–1844).—The early period may be regarded as opening with Dalton, who, in 1799, read a paper dealing with the transfer of heat in fluids. From his experiments Dalton perceived that heat transfer depends upon both convection and conduction. In 1800 he read a paper dealing with the change in temperature produced by the compression and rarefaction of air. In it he recorded the result that the temperature of air mechanically compressed to one-half its volume was raised 50 deg. Fah. Forty-five years later Joule stated that Dalton was the first who succeeded in measuring the change of temperature with some degree of accuracy. Dalton also investigated the expansion of gases when heated at constant pressure, and he obtained data very close to the values now accepted. Later in the same year he read a paper comprising four essays, dealing with gases and vapours. The first essay proposed laws which adumbrated the law, named after him, of partial pressures of mixed gases; the second dealt with the saturation pressures and temperatures of vapours from water and other liquids, and clearly defined the partial pressures of air and a vapour under a condition of saturation; the third dealt with evaporation of a liquid into surrounding "air," and investigated the influence of motion of the air upon evaporation from a surface, also the influence of the temperature of the air and that of the liquid; the fourth paper produced further experimental evidence upon the expansion of different gases, and ended with these words: "Upon the whole, therefore, I see no sufficient reason why we may not conclude that all elastic fluids under the same pressure expand equally by heat, and that for any given expansion of mercury, the corresponding expansion of air is proportionally something less, the higher the temperature." In this essay Dalton made the remarkable forecast, realised later by Joule, "that general laws respecting the absolute quantity and the nature of heat are more likely to be derived from elastic fluids than from other substances." To Dalton is due the credit of having discovered the law of equal expansion of gases. Gay Lussac, to whom it is often attributed, made known his discovery of the same law six months later than Dalton. In 1803 Dalton read a paper "On the Absorption of Gases by Water and other Liquids," in which he extended the work of Henry, his distinguished contemporary in Manchester and the discoverer of the law bearing his name, and dealt with the absorption of a mixture of gases by water; he showed that one gas can be partially removed from water in which it is dissolved by agitating the water in the presence of another gas, and indicated the extent to which the removal can occur.

Thus between Dalton, Henry, and Joule later, Manchester researches enjoy the distinction of having provided most of the laws of gases.

From this time onwards Dalton became absorbed in researches which led to his great discovery of the law of chemical combination in multiple proportions. His early researches upon gases and vapours, however, have provided principles of fundamental importance in several branches of engineering, notably in connection with steam condensers. Although Dalton's direct contribution to mechanical science was a highly important one, his indirect influence through his teaching and inspiration, though not so tangible, was in all probability no less valuable. Joule and Hodgkinson, to mention two of his pupils, worthily carried into the engineering field the pioneering character and spirit of bold inquiry of their great master.

* The Institution of Mechanical Engineers. Manchester meeting, June 25th, 1929.

James Prescott Joule (1818–1889).—If there is one research conducted in Manchester that stands before all others in importance in its connection with mechanical science it is that which led to the discovery and determination by Joule of the mechanical equivalent of heat. Few engineers, however, are aware of the extent of the ground covered by Joule in reaching his epoch-making generalisation, nor of the difficulties he encountered in winning acceptance of his views. The present opportunity is a very favourable one for retracing the steps taken by Joule in making his great contribution to physical and mechanical science, and consequently this research is dealt with in greater detail than others referred to in this paper.

Joule provided the foundations upon which the structure of engineering thermodynamics has been built up, and without the discoveries he made the edifice would not have been possible. No more inspiring example of co-ordinated research over a wide field, culminating in as fundamental a generalisation as the Law of the Conservation of Energy, is to be found in the annals of scientific discovery than Joule's investigations in electricity and magnetism, and of the equivalence of heat and work. And no action was more characteristic of the modesty of the discoverer than the manner in which the discovery was announced, not before a scientific body, but in a popular lecture at St. Anne's Church Reading Room on April 28th, 1847, entitled "On Matter, Living Force, and Heat."

By "living force" Joule referred to kinetic energy, and while much of his lecture was concerned with the dynamical character of heat and its conversion into potential and kinetic energy, he entertained the widest conception of the principle he had discovered, as witness these statements: "All three, therefore—namely, heat, living force, and attraction through space (to which I might also add *light*, were it consistent with the scope of the present lecture)—are mutually convertible into one another;" and "Indeed the phenomena of Nature, whether mechanical, chemical, or vital, consist almost entirely in a continual conversion of attraction through space, living force, and heat into one another." In referring to the lecture, Osborne Reynolds, in his extremely fine memoir of Joule, wrote: "This exposition, besides being the first ever given, was the only one Joule ever gave, except such as may be gathered from the general tenor of his writings." That he attached great importance to the lecture appears from the following note by Mr. Benjamin Joule, quoted by Reynolds: "James was very anxious that this lecture should be published in its entirety as soon as possible. One paper refused to give even a notice of it. After some discussion the *Manchester Guardian* would, as a favour, print extracts to be selected by themselves. This, of course, would not satisfy my brother. I returned to the *Manchester Courier* and, after a long debate, they promised to insert the whole as a special favour to myself."

This attitude may not be surprising when it is remembered that physicists of the time believed in the material theory of heat. For example, one year later, William Thomson, afterwards Lord Kelvin, wrote in a paper read at the Cambridge Philosophical Society: "the conversion of heat (or caloric) into mechanical effect is probably impossible, certainly undiscovered. In actual engines for obtaining mechanical effect through the agency of heat we must consequently look for the source of power, not in any absorption or conversion, but merely in a transmission of heat," and Joule, in Vol. 1 of his Scientific Papers, by a footnote to the conclusion of his paper "On the Mechanical Equivalent of Heat," communicated to the Royal Society in 1849, stated that "A third proposition, suppressed in accordance with the wish of the Committee to whom the paper was referred, stated that friction consisted in the conversion of mechanical power into heat." Continuing, Osborne Reynolds wrote: "Although this was fortunately preserved, the lecture was lost sight of till 1884, so that Joule's generalisation was not before the scientific world. Then, after about five years, as a consequence of the recognition of Joule's discoveries, the generalisation was borne in upon the minds of those who took up his work; and when expressed by Sir William Thomson as the law of conservation of energy, it was accepted as one of the fundamental laws of the universe."

The tardiness with which the results of Joule's researches and his views won acceptance must be attributed in part to his consummate skill as an experimenter. His conclusions were frequently based upon quantities of a magnitude which his contemporaries would have to consider as comparable with errors of observation. For example, in his paper "On the Changes of Temperature Produced by the Rarefaction and Condensation of Air," he says, after describing the calibration of a very sensitive thermometer: "When this was done it was found that ten divisions of the sensible thermometer (occupying about $\frac{1}{4}$in.) were nearly equal to the degree Fahrenheit; therefore since by practice I can easily estimate with the naked eye one-twentieth of each of these divisions, I could with this instrument determine temperatures to the 1/200 part of a degree. And in his paper "On the Effects of Magnetism upon the Dimensions of Iron and Steel Bars," he refers to having employed an extensometer in which each division of the micrometer indicated a change in length of the bar of 1/138,528in. Sir William Thomson, writing to Mr. J. T. Bottomley in 1882, records the incredulity of Graham and Miller regarding Joule's conclusions because they depended upon hundredths of a degree.

Rankine likewise, although accepting Joule's evidence upon the convertibility of work and heat, was at first sceptical as to the accuracy of his values on account of the extremely small variations of temperature. Later, however, he stated that his reflections on the accuracy of Joule's experiment "have convinced me that the uncertainty arising from the smallness of the elevation of temperature is removed."

Joule was fortunate in having had association from the age of sixteen years with Dalton, under whom, with his elder brother, Mr. B. St. J. B. Joule, his father intended he should study chemistry. This intention, however, did not materialise, as their instruction was terminated by a serious illness of Dalton when Joule was eighteen years of age, and at this stage Joule commenced his researches on magnetism and electricity which were the first steps in the path of great discovery. He was engaged in improving Sturgeon's electro-magnetic engine, and his second letter thereon, dated December 1st, 1838, when he was nineteen years of age, written to Sturgeon's "Annals of Electricity," reveals his passion for measurement and experiment, and gives an inkling of the direction he was to take.

Joule continued his researches in electro-magnetism and electro-magnetic forces with the object of improving the action of the electro-magnetic engine, and on February 16th, 1841, he gave a lecture at the Victoria Gallery, Manchester, entitled "On a New Class of Magnetic Forces," in which he announced the discovery of the influence of the back E.M.F. of an electric motor and its relation to the speed of rotation and field strength. He stated: "With my apparatus every pound of zinc consumed in a Grove's battery produced a mechanical force (friction included) equal to raise a weight of 331,400 lb. to the height of 1ft., when the revolving magnets were moving at the velocity of 8ft. per second. Now the duty of the best Cornish steam engine is about 1,500,000 lb. raised to the height of 1ft. by the combustion of a pound of coal, which is nearly five times the extreme duty that I was able to obtain from my electro-magnetic engine by the consumption of 1 lb. of zinc. This comparison is so very unfavourable that I confess I almost despair of the success of electro-magnetic attractions as an economical source of power; for although my machine is by no means perfect, I do not see how the arrangement of its parts could be improved so far as to make the duty per lb. of zinc superior to the duty of the best steam engines per lb. of coal."

Contemporaneously with his researches upon electro-magnetism and probably arising directly out of his investigations of the behaviour of his electro-magnetic engine, Joule was engaged in investigating the heating effects of an electric current, and a communication to the Royal Society, which was read in abstract on December 17th, 1840, entitled "On the Production of Heat by Voltaic Electricity," gave his conclusion: "that the calorific effects of equal quantities of transmitted electricity are proportional to the resistance opposed to its passage, whatever may be the length, thickness, shape, or kind of metal which closes the circuit." Osborne Reynolds remarks: "This paper from whichever point of view it is now viewed shows throughout the hand of a master; but the matter it contained was so far in advance of the knowledge of the time that the Royal Society declined to publish it in full in the 'Philosophical Transactions.'" Then followed a series of investigations upon the heat evolved by the passage of an electric current through metallic and liquid conductors, including voltaic batteries, from which he was led to speculate upon the electrical origin of heat. His results were embodied in two papers, read before the Manchester Literary and Philosophical Society. The following conclusions given in the second paper show that Joule's ideas of the convertibility of heat and work were beginning to take form:—

> "However we arrange the voltaic apparatus, and whatever cells for electrolysis are included in the circuit, the caloric of the whole circuit is exactly accounted for by the whole of the chemical changes.
>
> "4. Faraday has shown that the *quantity* of current electricity depends upon the number of chemical equivalents which suffer electrolysis in each cell, and that the *intensity* depends on the sum of the chemical affinities. Now both the mechanical and heating powers of a circuit are per equivalent of electrolysis in any one of the battery cells, proportional to its intensity or electromotive force. Therefore the mechanical and heating powers of a circuit are proportional to each other.
>
> "5. The magnetic electrical machine enables us to convert mechanical power into heat by means of the electric currents which are induced by it. And I have little doubt that, by interposing an electro-magnetic engine in the circuit of a battery, a diminution of the heat evolved per equivalent of chemical change would be the consequence and this in proportion to the mechanical power obtained."

In a footnote to this statement added three weeks later Joule wrote: "I am preparing for experiments to test the accuracy of this proposition." These experiments were undertaken and their results were embodied in a paper "On the Calorific Effects of Magneto-electricity and on the Mechanical Value of Heat" read before the Chemical Section of Mathematical and Physical Science of the British Association meeting at Cork on August 21st, 1843. In the opening paragraph Joule considers that if heat is regarded as a state of vibration there is no reason why it should not be induced by the mechanical action of revolving a coil of wire before the poles of a permanent magnet, but he indicates that there would still be a doubt whether the heat observed at a particular part of a circuit was generated or merely transferred from the coils. He makes a similar comment in connection with his work upon the heat evolved by a voltaic battery, and he wrote: "I resolved therefore to endeavour to clear up the uncertainty with respect to magneto-electrical heat." He proceeds: "The general plan which I proposed to adopt in any experiments under this head was to revolve a small electro-magnet, immersed in a glass vessel containing water between the poles of a powerful magnet, to measure the electricity thence arising by an accurate galvanometer, and to ascertain the calorific effect of the coil of the electro-magnet by the change of temperature in the water surrounding it."

Joule's experiments comprised the measurement of the heat generated for measured current conditions when his generator was excited, and unexcited, with its armature short-circuited, in series with external resistance, and in series with voltaic cells both acting with and against the electromotive force generated. Corrections were made for heat loss and, indeed, for armature iron losses and for those due to sparks at the commutator. Comparisons were made between the heat evolved, as a result of the current generated, by electro-magnetic action and of current produced entirely by voltaic batteries. Joule made allowance for the current wave form of his generator, which he recognised as a difficulty in comparing the heat evolved by the two means. His experiments led him to the conclusion that "the heat evolved by the coil of the magneto-electrical machine is governed by the same laws as those which regulate the heat evolved by the voltaic apparatus, and exists also in the same quantity under comparable circumstances;" and as a result of his experiments employing voltaic batteries acting with and against the magneto-electric generator he wrote: "We have therefore in magneto-electricity an agent capable by simple mechanical means of destroying or generating heat."

Having proved that the heat is generated by the magneto-electric machine, "it became an object of great interest to inquire whether a constant ratio existed between it and the mechanical power gained or lost," and further experiments were made in which the work done in driving the generator was measured. Joule found that within the variation permissible such a ratio did exist, and he wrote: "At present we shall adopt the mean result of the thirteen experiments given in this paper and state generally that: *the quantity of heat capable of increasing the temperature of a pound of water by one degree of Fahrenheit's scale is equal to, and may be converted into, a mechanical force capable of raising* 838 *lb. to the perpendicular height of one foot.*"

Joule saw at once the application of his discovery to engineering, and he proceeds: "Among the practical conclusions which may be drawn from the convertibility of heat and mechanical power into one another, according to the above absolute numerical relations, I will content myself with selecting two of the more important. The former of these is in reference to the duty of steam engines; the latter to the practicability of employing electro-magnetism as an economical motive force."

In connection with the former he makes what is the first calculation of thermal efficiency and arrives at a figure of about 10 per cent. for the best Cornish engines, and in the latter concludes that: "the electro-magnetic engine, worked by the voltaic batteries at present used, will never supersede steam in an economical point of view." In a postscript to the paper he adds: "I have lately proved experimentally that *heat is evolved by the passage of water through narrow tubes*. My apparatus consisted of a piston perforated by a number of small holes, working in a cylindrical glass jar containing about 7 lb. of water. I thus obtained one degree of heat per lb. of water from a mechanical force capable of raising 770 lb. to the height of one foot, a result which will be allowed to be very strongly confirmatory of our previous deductions. I shall lose no time in repeating and extending these experiments, being satisfied that the grand agents of Nature are, by the Creator's fiat, *indestructible*, and that whatever mechanical force is expended, an exact equivalent of heat is *always* obtained."

Hitherto, except for the experiments upon fluid friction just mentioned, Joule had pursued his investigations by the medium of electrical and magnetic phenomena. He now gave his attention to a research which he recognised was of fundamental interest and importance to mechanical engineers in connection with the theory of the steam engine, and set about determining the mechanical equivalent of heat by measuring the heat generated when air is compressed. It was in connection with this research that he constructed his thermometer, already referred to, with which he read to 1/200th of a degree Fahrenheit. Osborne Reynolds, in commenting upon the research, said: "The difficulties of the inquiry were, however, so great as to have been impossible to any one but Joule."

Joule measured the heat evolved when air was compressed and the amount that disappeared when it expanded doing work on the surrounding atmosphere. His research included his famous experiment in which compressed air in one vessel was expanded into another vessel originally evacuated whereby no external work was done, and no change in temperature was measured. These experiments were not only fundamental to the foundation of the dynamical theory of heat, but they led to an enunciation for the first time of the correct action of heat in the steam engine. The results of this research were communicated to the Royal Society. Joule obtained values of the mechanical equivalent of heat of 823, 795, 820, 814, and 760, and as he regarded the last three as least liable to error, he took the mean to be 798 ft.-lb., which he stated was "a result so near 838 lb., the equivalent which I deduced from my magnetical experiments, as to confirm, in a remarkable manner, the above explanation of the phenomena described in this paper, and to afford a new and, to my mind, powerful argument in favour of the dynamical theory of heat."

The accuracy with which he saw the application to the steam engine of the principle he had discovered is revealed by the following extract from his paper: "The principles I have adopted lead to a theory of the steam engine very different from the one generally received, but at the same time much more accordant with facts. It is the opinion of many philosophers that the mechanical power of the steam engine arises simply from the passage of heat from a hot to a cold body, no heat being necessarily lost during transfer. . . . I conceive that this theory, however ingenious, is opposed to the recognised principles of philosophy. . . . The principles, however, which I have advanced in this paper are free from this difficulty. From them we may infer that the steam while expanding in the cylinder, loses heat in quantity exactly proportional to the mechanical force which it communicates by means of the piston, and that on the condensation of the steam the heat thus converted into power is *not* given back. Supposing no loss of heat by radiation, &c., the theory here advanced demands that the heat given out in the condenser shall be less than that communicated to the boiler from the furnace, in exact proportion to the equivalent of mechanical power developed."

The paper was read before the Royal Society on June 20th, 1844, but it was rejected for publication in the "Proceedings," and was published in the *Philosophical Magazine* in May, 1845.

Within twelve months Joule made further experiments upon the mechanical equivalent of heat, this time by means of water in a calorimeter stirred by a paddle. The results were communicated to the Cambridge meeting of the British Association, June, 1845. In a letter to the *Philosophical Magazine*, dated August 6th, 1845, supplementing this communication, he summarises the values of the mechanical equivalent of heat determined by the various methods he had employed, and in speculating upon the quantity of heat in matter he discovered the existence and position of the absolute zero of temperature. In May, 1847, Joule gave the lecture already referred to, in which he announced the law of conservation of energy, and in June of that year he presented a paper at the Oxford meeting of the British Association in which he reported the results of further paddle experiments employing water and sperm oil. In these he found that the work required to produce heat sufficient to raise 1 lb. of water 1 deg. Fah. was 781·5 and 782·1 foot-pounds respectively. A further contribution to the subject was made at the Swansea meeting of the British Association in August, 1848, when Joule gave the average value of the mechanical equivalent of heat based upon forty determinations as 771 foot-pounds, a value which he believed to be within 1/200 of the truth.

On June 21st, 1849, Joule's classical paper entitled "On the Mechanical Equivalent of Heat" was read before the Royal Society. This research upon the mechanical equivalent of heat is the one best known to succeeding generations of engineers. The research covered five series of experiments comprising one on water, and two each upon mercury and cast iron.

The following table reproduces Joule's summary of his results.

TABLE I.—*Summary of Joule's Determinations of the Mechanical Equivalent of Heat.*

No. of series.	Material employed.	Equivalent in air.	Equivalent in vacuo.	Mean.
1	Water	773·640	772·692	772·692
2	Mercury	773·762	772·814	774·083
3	Mercury	776·303	775·352	
4	Cast iron	776·997	776·045	774·987
5	Cast iron	774·880	773·930	

Joule considered his results for water to be the more correct, and his paper ends with the conclusions:—

"First, that the quantity of heat produced by the friction of bodies, whether solid or liquid, is always proportional to the quantity of force expended; and

"Secondly, that the quantity of heat capable of increasing the temperature of a pound of water (weighed in vacuo, and taken between 55 deg. and 60 deg.) by 1 deg. Fah. requires for its evolution the expenditure of a mechanical force represented by the fall of 772 lb. through the space of one foot."

A third proposition, as we have already noted, was suppressed.

Joule was then thirty-one years of age, and it may truly be said that he had completed the most valuable part of his life's work. In a period of twelve years his researches had produced important discoveries in electricity and magnetism, he had established the dynamical character of heat, discovered the law of conservation of energy, discovered and estimated the absolute zero of temperature, provided a basis without which the thermodynamics of heat engines could not have been developed, made the first determination of the thermal efficiency of a heat engine, and discovered the mechanical equivalent of heat which he measured with a skill in experiment unapproached in his day.

From this time onwards Joule conducted a number of researches of importance in mechanical science. In 1855 he invented electric welding of metals and proved its practicability. In 1856 he gave a paper to the Manchester Literary and Philosophical Society entitled "On the Fusion of Metals by Voltaic Electricity." In this paper he not only foresaw that "in many instances the process would advantageously supersede that of soldering," but he envisaged the possibility of electric melting of iron and estimated its cost. After calculating the amount of zinc necessary to melt iron, he said: "The quantity of zinc consumed in the voltaic process is therefore nearly equal to that of the iron to be melted, but it would be possible to effect the same object in a more economical manner by availing ourselves of the use of the magneto-electrical machine. This machine enables us to obtain heat from ordinary mechanical force, which mechanical force may again be derived from the conversion of heat, as in the steam engine . . . it is possible to arrange machinery so as to produce currents of electricity which shall evolve one-tenth of the quantity of heat due to the combustion of the coal employed. So that 5000 grains of coal used in this way would suffice for the fusion of one pound of iron."

This figure is within about 30 per cent. of what can be obtained to-day.

In 1859 Joule, in association with Sir William Thomson, made experiments upon the heat developed by friction in air, and it was discovered that the rise in temperature of the bulb of a thermometer whirled in air was proportional to the square of the velocity except at low velocities. He wrote: "We surmised that this was owing to a sort of fluid friction different from the source of resistance at high velocities." At the same period he was engaged upon research upon the thermodynamic properties of solids, verifying by experiment the predictions made by Sir William Thomson, and a little later short papers were presented to the Manchester Literary and Philosophical Society relating to the hydraulic testing of steam boilers, the total heat of steam, upon the flow of air through pipes and orifices, and upon amalgams.

An important contribution was made by Joule upon the subject of the surface condensation of steam, the results of his research being communicated to the Royal Society in 1860 in a paper "On the Surface Condensation of Steam." Joule wrote that this research "left much to be accomplished. One of my chief objects was to obtain figures which might prove useful to practical men, and I have therefore confined myself to such tubes as were most likely to be generally used." But its comprehensive character is shown by the fact that he investigated the influence of speed of flow of water, the effect of having the steam and water flowing in the same, and in opposite directions, the influence of the radial dimension of the water stream, which was formed between the steam tube and a concentric outer tube, the influence of causing the water to flow spirally, the effect of surface contamination and of different metals, and the use of air as the cooling medium. In connection with this research, Sir William Thomson provided the now well-known logarithmic expression for heat transmission through a tube from steam on one side to a cooling medium flowing axially on the other side, and Joule employed it to calculate the conductivity. The illuminating character of Joule's work will be judged by the following extracts from his conclusions: "The resistance to conduction is to be attributed almost entirely to the film of water in immediate contact with the outside and inside surfaces of the tube, and is little influenced by the kind of metal of which the tube is composed or by its thickness within the limits of ordinary tubes, or even by the state of its surface as to greasiness or oxidation. The conductivity increases as the rapidity of the stream of water is augmented." Referring to the experiments with air as the cooling medium, Joule wrote: "That the velocity of the elastic fluid appears to exercise a much more considerable influence on the conductivity than it does in the case of water," and "That spirals exercise a beneficial influence."

During the next twenty years Joule published a number of papers, and it is very appropriate that the two of most note were concerned with redeterminations of the mechanical equivalent of heat, one on the "Determination of the Dynamical Equivalent of Heat from the Thermal Effects of Electric Currents," which was presented at the Dundee meeting of the British Association, 1867, and the other entitled "New Determination of the Mechanical Equivalent of Heat" was read before the Royal Society on January 24th, 1878.

William Fairbairn (1789–1874).—The researches of Henry, Dalton, and Joule were of a purely scientific character, and, unfortunately, as frequently happens in such cases, a considerable interval of time elapsed before the importance of the results obtained were appreciated and applied. Much engineering research is of quite a different kind. Progress often waits upon the provision of specific information which, when obtained, is utilised immediately. Railway construction with all the pioneer work it involved—when almost every new work of any magnitude was largely an experiment—and the contemporary rapid increase in the use of metals for constructional purposes brought with them an urgent need for knowledge of the properties and behaviour of metals and structures. This necessity was felt acutely by the leading engineers of the day, and none appreciated it more completely, or did more to carry out or promote research to satisfy it, than Fairbairn.

Fairbairn was a born engineer, possessing all the qualities necessary for the execution of large enterprises, and although, perhaps, of limited technical attainments, he appreciated and was able to employ them in others. Thus in much of his earlier work he was fortunate in having the assistance and collaboration of Eaton Hodgkinson, who, in his day, was probably the leading authority in the country upon the theory and strength of materials and whose work in Manchester we shall have to consider. In later years he obtained mathematical and other asistance from Mr. Thomas Tate, to whom he records his indebtedness. Nevertheless, combined with his strong practical genius was a philosophical bent and a desire to base his actions upon fundamental and precise knowledge. This impelled him to initiate and carry through researches in all branches of engineering, often upon a gigantic scale. He was a pioneer in so many fields that an opinion of his chief contributions to engineering must depend upon the branch considered. From our standpoint his most important contributions to mechanical science were in the testing of materials and structures in which he was this country's foremost pioneer.

Fairbairn's early researches in Manchester were concerned with the strength of cast iron, which was then the most important constructional metal. He conducted numerous transverse tests upon cast iron drawn from practically every source in the country. He made an extensive investigation of the transverse strength of cast iron produced by the hot and cold-blast processes and presented his results in a paper read before the British Association in 1837. This communication included the results of some tests, made at Hodgkinson's suggestion, to determine the influence of long-continued loads upon the deflection of cast iron beams and a few tests of the usual short-time kind made at temperatures ranging from 10 deg. to 600 deg. Fah.

Fairbairn at that time was in partnership with a Mr. Lillie in a millwrighting and general constructional engineering business at works in Mather-street. In 1832 he dissolved his partnership with Lillie and started a new works in Canal-street, Ancoats. It was at these works that he constructed and installed his single lever testing machine, which was used for much of the heavier testing done by him in Manchester and which he generously placed at the disposal of Hodgkinson. Indeed, it seems doubtful whether Hodgkinson could have made the researches we shall refer to later but for the material and financial assistance he received from Fairbairn.

In 1838 Fairbairn, with the assistance of Hodgkinson, carried out the greater part of what was probably the first extensive investigation of the strength of riveted joints. Except for some additions made the following year, the investigation was suspended and not completed until about 1850, when the results were published. The research, which was divided into four parts, was undertaken specifically in connection with the construction of iron ships, in the development of which Fairbairn had taken a leading part. He remarked: "I hope in the following experiments to show that the iron ship, when properly constructed, is not only more buoyant but safer and more durable than vessels built of the strongest English oak."

The four parts were:—

(1) The strength of plates when torn asunder by a direct tensile strain in the direction of the fibre, and when torn asunder across it.

(2) On the strength of the joints of plates when united by rivets as compared with the plates themselves.

(3) On the resistance of plates to the force of compression, whether applied by a deadweight or by impact.

(4) On the strength and value of wrought iron frames and ribs as applied to ships and other vessels.

The following summary gives an idea of the experimental work embraced by these parts, the tests for which were carried out upon the testing machine illustrated by Fig. 1:—

Part 1.—A comparison was made of the tensile strength of wrought iron plates of different manufacture tested both along and across the direction of rolling. Little difference in strength was found for the two directions, and no account appears to have been taken of ductility. The results provided a basis with which to compare the strength of riveted joints dealt with in Part 2.

Part 2.—Attention was given to the strength of joints made with machine and hand-closed rivets, and the strengths of the following joints were measured and compared:—Single and double-riveted lap joints, butt joints

with one cover plate having rivets closed with countersunk and snap heads, butt joints single and double riveted with two cover plates. The strengths of single and double-riveted joints were summarised and proportions for their satisfactory design were laid down.

Part 3.—The capacity of wrought iron plates and oak planks to resist indentation by a rounded object was determined, the purpose of this investigation being to compare the risk of damage of the two materials when a vessel

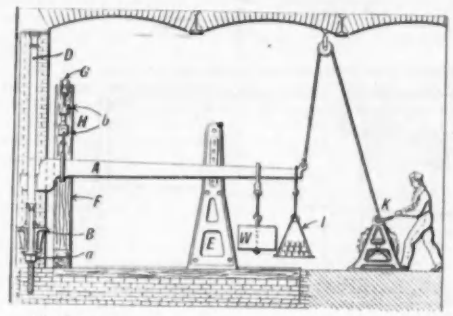


FIG. 1.—*Fairbairn's Testing Machine used for Tensile Tests.*
(Reproduced from the Philosophical Transactions of the Royal Society.)

rested upon a shore strewn with stones and boulders. The test employed for the plates, as will be seen from Fig. 2, may be regarded as the precursor of the Erichsen test now used to measure the ductility of sheet metals.

Part 4.—Strength and deflection tests were made upon beams of rolled and built-up sections of T and I form. The results were used to compare the dimensions and weights of the beams tested with those of best oak beams of square section of equal strength. Although the comparison of test results was slightly in favour of oak, Fairbairn concluded that owing to greater economy in construction the advantage in practice would be strongly in favour of iron—a conclusion fully substantiated by subsequent experience.

Fairbairn possessed another works at Millwall, London, intended principally for the construction of iron ships, and it was at this works that his tests upon models in connection with the Conway and Britannia bridges were made. As this investigation was controlled by Fairbairn with headquarters in Manchester, the experimental work

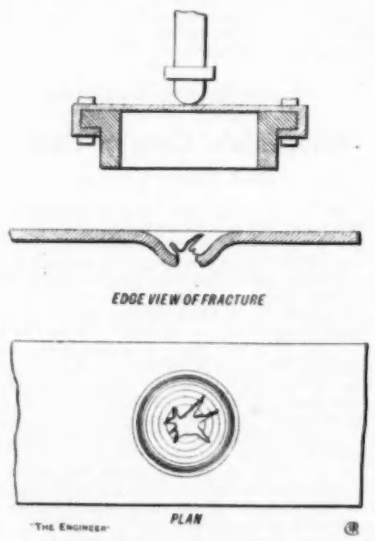


FIG. 2.—*Fairbairn's Indentation Test for Plate Material.*
(Reproduced from the Philosophical Transactions of the Royal Society.)

being done at Millwall solely on account of the constructional facilities he possessed there, it may with every justification be regarded as a Manchester research.

After having considered numerous schemes for a bridge over the Menai Straits, Robert Stephenson conceived the original idea of a huge tubular structure to be built up of riveted plates, and in April, 1845, he consulted Fairbairn for his opinion as to the practicability of the scheme and the means necessary for carrying it out. From this time Fairbairn became engaged with Stephenson in dealing with the many problems associated with the projected construction, and in July, 1845, he made his first experiment upon the strength of a sheet iron tube 18ft. long, 12in. diameter, and 0·0408in. thick tested as a beam upon a 17ft. span. In September of that year, realising the need of expert assistance, Fairbairn obtained the benefit of Hodgkinson's help. There is a little difficulty in assessing Hodgkinson's position in the undertaking. According to Fairbairn, it was at first intended by Stephenson that a joint report upon the proposed bridges, signed by all three, should be made to the directors, but actually in February, 1846, three separate reports were made.

Relying almost entirely upon tests, Fairbairn pursued his objective by a trial-and-error method, and doubtless was led into making many more tests, and upon a larger scale than would have been necessary with a better use of theoretical treatment. How far the course taken by Fairbairn was essential, however, it is difficult to judge. Progress was reported regularly to Stephenson. In May, 1846, Fairbairn's position was made definite, as the directors of the Chester and Holyhead Railway appointed him, according to their minute, "to superintend the construction and erection of the Conway and Britannia bridges in conjunction with Mr. Stephenson."

Between July, 1845, when Fairbairn made his first model test, until April, 1847, when he attained the results for which he had been striving, forty-one tests upon scale models had been made. These models were of various forms; the early tests were made upon cylindrical tubes and a few upon tubes of elliptical and rectangular cross-section. Failure by the crippling of plates under compressive stress was the great difficulty preventing the full utilisation of the strength of the material. This led to the reinforcement of the compression side and eventually to the use of a cellular construction there. The later experiments were made upon a model one-sixth scale, of the projected Britannia bridge. This huge model had a rectangular cross section as shown by Fig. 3 and a free span of 75ft. The cellular construction of the compression side will be observed. Nine series of load-deflection tests were made

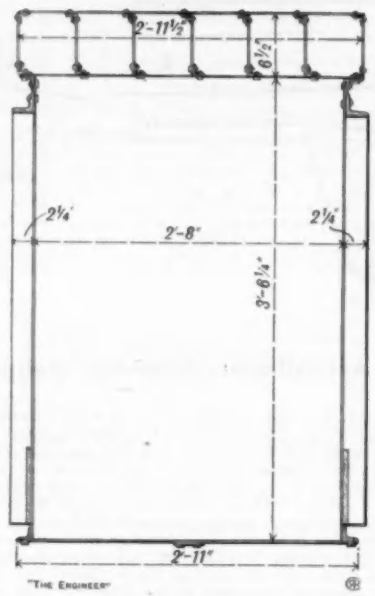


FIG. 3.—*Cross Section at the Centre of Model of Britannia Bridge Tube.*

starting with a cross section in which the tension side was purposely made deficient in strength. At every failure of this side the model was repaired and the tension side strengthened until in the final test failure occurred by the crippling of the compression side. By this means the requisite balance in strength of the tension and compression sides and the maximum resistance of the tube was attained. Failure occurred under a concentrated load of 86 tons and a maximum recorded deflection of 4·81in. It is perhaps not surprising to know that the finance committee of the railway company remarked upon the cost of the experiments, in connection with which Stephenson wrote to Fairbairn: "The real cause of the remark arose from our having stated in the first instance that the experiments we proposed to make would cost under £3000, whereas now they appear likely to exceed £6000."

It is doubtful whether model tests of structural members upon the scale carried out by Fairbairn in connection with the Conway and Britannia bridges have been surpassed since his day, and it is a tribute to the genius of Stephenson and the results of these researches that both these bridges carry the London, Midland and Scottish Railway main line traffic to Holyhead to-day.

Fairbairn's works at Millwall were never successful financially, although a considerable number of iron ships were built. The construction of models and tests made for the Conway and Britannia bridges constituted the last work executed there by Fairbairn prior to the plant being dismantled and the premises sold. The Manchester works, however, were highly successful and a large volume of business was executed in the construction of engines, boilers, and locomotives.

It is of interest to mention in this connection that Fairbairn has been credited with the invention of the tank type of locomotive, and in 1844 in conjunction with John Hetherington he invented the Lancashire boiler. It will be understood, therefore, that he had considerable interest in the construction, operation, and safety of steam boilers, and we find that his expert opinion was frequently sought in connection with explosions, which at that time occurred in stationary boilers with alarming frequency and disastrous results to life and property.

Arising from an explosion of a locomotive boiler in which the fire-box was completely wrecked, Fairbairn, in making an investigation into the cause, carried out a number of useful tests upon the strength of screwed and riveted copper stays and the resistance of flat-stayed surfaces. The results were valuable in that they demonstrated the ample strength of the proportions then employed, and the cause of failure had to be sought in another direction. Incidentally, as indicating the rather lax conditions prevailing in those days, it would appear that a safety valve could be screwed down by the engine driver or boiler attendant, and it was not appreciated that a closed boiler when fired developed pressure at an increasing rate as the pressure increased, and consequently neglect for a short time under such circumstances might be critical and result in disaster. This example is typical of the very practical way in which Fairbairn carried out an investigation. A similar full-size boiler was tested by hydraulic pressure to over three times the working pressure and its behaviour observed; detail tests were made upon stays in plates and stayed flat surfaces, and finally tests were made upon a closed boiler, the rate of increase of temperature and pressure was measured, the law of increase was determined, and the time required to produce failure was estimated and found to be of the order that might easily occur.

At that time and for many years later mysterious causes were often suggested to account for boiler explosions instead of the simple one of excessive working pressure and stress, which was frequently the correct explanation. Conditions were so unsatisfactory that legislative restrictions would inevitably have been introduced if steps had not been taken voluntarily to provide for the regular inspection of boilers. The need for a scientific association to provide for the inspection of boilers and to carry out research necessary for their safety and economical operation must have occurred to Fairbairn, but no action was taken by him until a Mr. R. Johnson wrote suggesting the idea to him. Fairbairn interested Mr. Henry Houldsworth and Sir Joseph Whitworth in the matter, and it was decided to take steps to form such an association. A circular was issued over their signatures outlining the proposal for an "Association for the Prevention of Steam Boiler Explosions, and the Promotion of the Economical Working of such Boilers." An inaugural meeting was held in the Town Hall, Manchester, on September 19th, 1854, and the Association was launched, with the title of "The Association for the Prevention of Steam Boiler Explosions and for Effecting Economy in the Raising and Use of Steam," later being known as "The Manchester Steam Users' Association for the Prevention of Boiler Explosions and for the Attainment of Economy in the Application of Steam."

Reference to this Association has been made here because of the valuable research it has conducted, to which attention will have to be paid later, and the important part taken by Fairbairn in its formation and development, a part referred to by a memorandum of this Association in the following words: "not only the creation of this Association, but its beneficial influence and its continued activity as a scientific institution, were due almost entirely to Sir William Fairbairn."

From this time onwards Fairbairn's published researches reveal his increasing interest in matters relating to steam engines and boilers. In 1856 he read a paper giving the results of his investigation of the strength of wrought iron plates and rivet iron at different temperatures. The research was an extensive one covering the range of temperature from 0 deg. to 410 deg. Fah. and 435 deg. Fah. in the case of plates and rivet iron respectively, with the addition of tests in each case at a low red heat. The results showed that, in the case of plates, no fall in strength occurred up to a temperature of 395 deg. Fah., and in the case of rivet iron there was an appreciable accession of strength over the range of experiment except at red heat, the maximum strength being obtained at 325 deg. Fah. In these tests the extension was measured, and it may be mentioned that the proportions of the test pieces employed in the case of rivet iron corresponded closely with the British Engineering Standards Association test piece "C" employed to-day. In view of the attention now being given to the properties of materials at high temperatures, this pioneer and valuable contribution of Fairbairn must be regarded as of special historical interest.

At the joint request of the Royal Society and the British Association, Fairbairn carried out his famous researches into the collapse of cylindrical vessels under external pressure, his paper thereon being presented in 1858. The need for this research arose from the many disastrous boiler explosions that occurred about that time which were associated mainly with the increase in working pressures that followed upon the expansive working of steam in engines. On account of the scale of the parts to be tested special facilities in the way of pumps and lifting appliances were necessary, and these were found at the Longsight engine-house of the London and North-Western Railway Company, whose directors gave permission for their use. Fairbairn records that he had the benefit of the suggestions and experience of Mr. J. Ramsbottom, the company's engineer, and the constant attendance of Mr. R. B. Longridge, the engineer and chief inspector to the Association for the Prevention of Boiler Explosions which had subscribed towards the cost of the research.

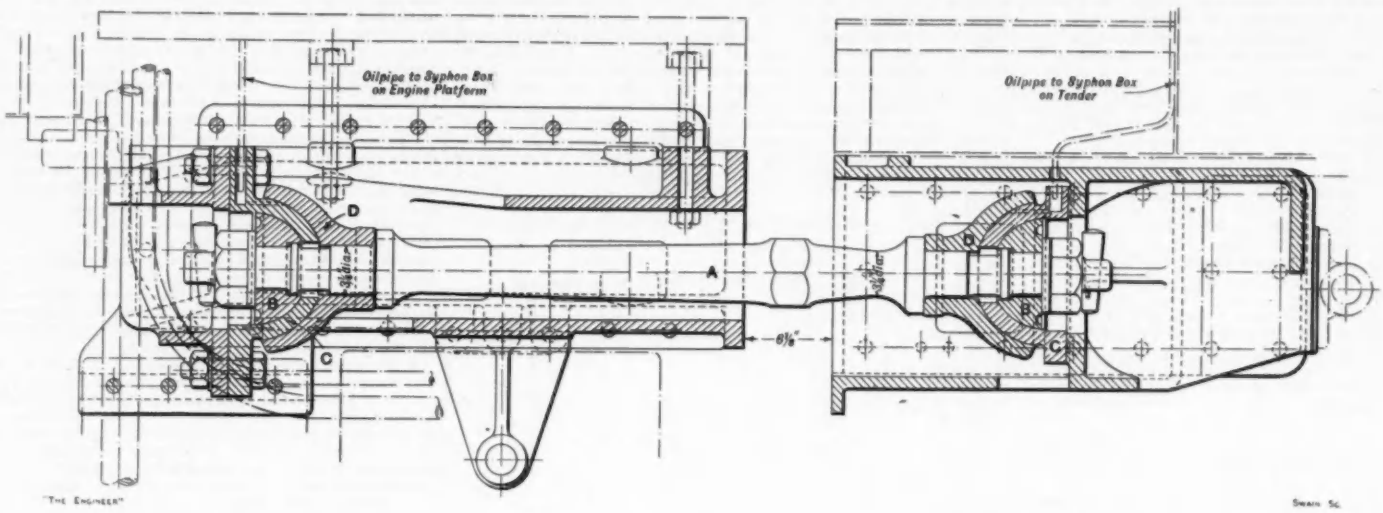
Thirty of the forty-two tests carried out were made upon thin cylindrical tubes ranging in diameter from 4in. to 12in., and in length from 19in. to 60in., the maximum that could be accommodated within the testing chamber. These tubes were made from plate 0·043in. thick, joined by a longitudinal seam by riveting and brazing, and the ends of a tube were constrained by being riveted and brazed to cast iron discs. Two cases were taken, (*a*) where axial movement of the end discs was free to take place, and (*b*) where this movement was prevented. The influence of stiffening rings was ascertained by one of these tests in conjunction with three others upon tubes approximately 15in. diameter and 0·25in. thick, stiffened by Adamson rings each built up of three sections, two tubes being flanged at the ends of each section and reinforced by a stiffening or caulking ring. Two steel tubes of elliptical form were tested to ascertain the influence of departure from the cylindrical form upon the resistance to collapse, and seven tests were made to determine the strength of tubes under internal pressure. Two of these were made upon lead pipes, their purpose being to throw light upon the question of how far the ends of a cylindrical vessel afford support against bursting.

The result of this investigation was the derivation of Fairbairn's well-known formula for the strength of wrought iron tubes subjected to external pressure, and a very considerable advance in the design of steam boilers having internal flues, such as his own or Lancashire boiler.

Joule and Thomson's work upon gases which showed that in the region of saturation the specific volume would be expected to depart considerably from that determined from the laws of a perfect gas, and Rankine's determination on the same subject in 1855 impressed upon Fairbairn the need for experimental determinations to be made of the specific volume of saturated steam over such a range of pressures as engineers employed. In conjunction with Tate he carried out a research upon this subject over a range of pressures from 2·5 lb. to 70 lb. per square inch, the results of which were presented in a paper read before the Royal Society in 1860. The principle of the apparatus employed was ingenious, and the results obtained marked an important advance upon earlier data. Although, compared with the very precise knowledge we have to-day of the properties of steam, the results were somewhat irregular, the investigation was a very useful contribution in the advance to our present knowledge. It will be of interest to mention that Mr. W. C. Unwin—now Dr. W. C. Unwin, F.R.S.—took part in this investigation.

THE GOODALL ARTICULATED DRAW-BAR COUPLING

THE A.B.C. COUPLER AND ENGINEERING COMPANY, WOLVERHAMPTON, ENGINEERS



The question whether metals retained their phyical properties when under stress in service was a matter that had already received some attention. Fairbairn in his investigation of cast iron had made a few tests upon the action of prolonged loads, and wrote: "It would appear from these experiments that time is an element which in a greater or less degree affects the security of materials when subjected to long-continued pressure." Tests had been made by others upon the action of repeatedly applied loads and impact, and some ideas upon the condition of safety in the case of cast iron had been obtained, but no research of any consequence had been carried out upon what has become known as "fatigue." Fairbairn wrote: "It has been assumed, probably not without reason, that wrought iron of the best and toughest quality assumes a crystalline structure when subjected to long and continuous vibration . . . it becomes brittle and liable to break with a force considerably less than that to which it had been previously subjected. This is not improbable, but we are apparently yet ignorant of the causes of this change and the precise conditions under which it occurs." He added: "It is immaterial whether the body be crystalline, homogeneous, or elongated into fibre, such as cast or wrought iron; the question to be solved is how long will a body of this description sustain a series of strains produced by impact (or the repeated application of a given force) before it breaks?"

The matter was one of very considerable importance, and at the request and with the support of the Board of Trade, Fairbairn carried out what was probably the first systematic investigation of the endurance of wrought iron not in the form of small test pieces but upon a built-up girder. A single lever was used for loading the girder under test at the middle of its span, and the load was periodically removed at about eight times per minute by means of a connecting link driven by gearing which raised the end of the loading lever and thereby relieved it and consequently the girder of load.

The girder tested was supported on piers 20ft. apart and the load applied, namely, 2·96 tons, was considered to be one-quarter of the breaking load. After more than half a million applications of this load had been made without any sign of fracture, the load was increased to 3·5 tons, or two-sevenths of the static breaking weight, and the number of applications of load from the commencement of the test was brought up to one million, but without any sign of failure occurring. The load was increased again to 4·68 tons, or two-fifths of the breaking weight, and after sustaining a further 5175 applications of load the beam failed by tension a short distance from the middle. The beam was repaired and the tests continued. A load of 2·96 tons, one-quarter the breaking load, was applied over three million times without any apparent damage, after which it was increased to one-third the breaking weight, and failure ensued after just over 300,000 applications.

Fairbairn concluded from his tests that a tensile stress of 7 tons per square inch repeatedly applied is unsafe for wrought iron, but one of 5 tons per square inch, the maximum fixed by the Board of Trade, provides ample safety. Indeed, allowing for the area occupied by rivet holes, he concluded that a wrought iron bridge would be perfectly safe for a long series of years with a stress of 6 tons per square inch, or one-fourth the static breaking weight. He appeared to have some doubt, however, about unlimited resistance at apparently safe stresses, for he wrote: "It is, however, evident from these experiments that time is an element which enters into the resisting powers of materials of every description when subjected to a continued series of changes. These may be very minute, but assuming them to be of sufficient force to produce molecular disturbance, it then follows that rupture must eventually ensue."

To Fairbairn is due the credit of having initiated systematic investigation of fatigue, and although in the meantime the phenomenon has been largely and very properly dealt with by means of test pieces, there are many cases to-day where to obtain useful results actual parts must be tested.

Many of Fairbairn's researches in strength of materials were of a confidential character carried out for the Government in connection with ordnance and armour plate, and the data obtained therefore have not been published. Sufficient has been given of his published work, however, to indicate the value of his researches in this field, and, what is of greater importance, the part they played in establishing the scientific testing of materials.

(To be continued.)

An Articulated Draw-bar Coupling.

WHEN one comes to think of it, it is an extraordinary thing that so little attention has been devoted to the coupling between locomotives and their tenders. They are usually tied together either by a central draw-bar provided with a strong spring which draws the adjacent curved faces of two central rubbing blocks together, or by a central draw-bar without springs and side buffers with them. Neither plan is mechanically perfect. Stand in the cab of an engine running at speed, with one foot on the footplate of the engine and the other on the footplate of the tender, and a physical experience of the violent relative motion of the parts will be obtained. That motion cannot be restrained or prevented without making the combination of engine and tender too rigid. An attempt must therefore be made to allow it to take place as easily and sweetly as possible, with little friction and without bumps and jars. Apparent satisfaction of some of the requirements can be attained by increasing the tension of the springs, but if side buffers are used the resistance to bending when taking a curve is increased, and if central buffing blocks are fitted they rub hard together. What happens as a rule is that the spring tension is allowed to diminish until the coupling works freely—but often unpleasantly.

It should be quite possible to make a really good mechanical union, a true articulation, which would leave all desirable freedom, whilst employing determinate joints that could be properly lubricated. That object seems to have been attained by the coupling made by the A.B.C. Coupler and Engineering Company, of Wolverhampton, to the designs of Mr. C. N. Goodall, of Robert Stephenson and Co., Ltd., of Darlington, which is illustrated (in the form adopted by a broad-gauge Indian railway) by the accompanying drawing. It will be seen at once that it is a thoroughly mechanical arrangement. In the first place, there is the draw-bar itself, marked A. On each end of it there is mounted a cup D and a half-ball B. These two parts are machined accurately to shape. Between them there is enclosed a cup-shaped member C, accurately machined on both its inner and outer faces. These parts C are attached to the two drag-boxes, one on the engine, the other on the tender. A hole through the base of C is big enough to allow all the play that is necessary, whilst oil pipes from suitably placed reservoirs lubricate these half-ball joints. There is no slackness anywhere, and from a personal test we can say that the joints work with quite remarkable ease and sweetness.

It must be assumed that such a real mechanical engineering job is more expensive than the usual type of coupling, but we think there can be little or no doubt that, being a good mechanical engineering job, it will cause less wear and tear and in the long run will pay for itself, as everything that is scientifically designed and well made does. The absence of any springs alone must have a marked effect upon the side resistance when rounding curves, which, being of necessity transmitted to the wheels, causes wear of the tires and friction on the bearings. It gives the tender a perfectly free articulation with the engine, and that is just what is wanted.

WORLD AGRICULTURAL TRACTOR TRIALS.

UNDER the auspices of the Royal Agricultural Society of England in conjunction with the Institute of Agricultural Engineering, University of Oxford, some world agricultural motor trials are to be held in this country next year.

The following regulations under which the trials will be carried out, have been issued by the Society:—The trials will consist of two parts:—(*a*) Tests of a scientific and practical nature, not open to the public; and (*b*) a demonstration open to the public. They will be open to machines manufactured in any country in the world, and there is no restriction as to weight or horse-power.

The classes under which machines may be entered are:—

CLASS A. Direct haulage tractors capable of field operations—hauling ploughs, cultivators, harvesting machinery, &c., in work—of road haulage, and of driving stationary machinery. The power unit may be:—(*a*) Internal combustion engine; (*b*) steam engine; (*c*) electric motor.

CLASS B. Cable sets with ploughing or cultivating implements. The power unit may be:—(*a*) Internal combustion engine; (*b*) steam engine; (*c*) electric motor.

CLASS C. Self-propelled ploughing or cultivating machinery, not necessarily suitable for general haulage.

CLASS D. Special machines not covered by the above classes but which are self-propelled and capable of field operations.

The tests will be carried out between June 1st and September 1st, 1930. For them, each machine will be required for a period of about fourteen days. The public demonstration will take place on September 16th to 19th, 1930—both days inclusive—during which the entrants will be required to give a demonstration of their machines in work from 10 a.m. to 5 p.m. daily. The trials—tests and public demonstration—will be held on sites within twenty miles of Oxford. For the tests the Society will supply petrol, paraffin, crude oil, coal and electricity. Any special fuel must be supplied by the entrant.

Entries must be made on forms which may be obtained on application to the Secretary, Royal Agricultural Society of England, 16, Bedford-square, London, W.C. 1, from whom further particulars may be obtained.

Rhodesia's Copper Belt.

(From a South African Correspondent.)

IT is quite clear from the borehole results that are being obtained by the various companies which are developing copper properties in Northern Rhodesia, and surveying the huge areas over which they hold prospecting rights, that the extent of the copper fields and the huge quantities of high grade copper ore which they contain is beyond estimation as yet, and is likely to exceed the anticipations of the greatest optimists of to-day. Up to the present it may be said that four properties have been so proved by drilling, supplemented by extensive underground work, that they are known to contain over 100,000,000 tons of ore, none averaging below 3 per cent., and many millions of tons averaging 4·5 to 5 per cent., while at the N'Changa Mine the ore is assaying from 7 to 11 per cent., and in some parts 28 per cent. has been obtained. But, in addition, there are other properties which are in the initial stages of development, and, though they are known to have enormous tonnages, the actual volumes and values cannot yet be expressed in figures likely to be even a rough approximation. That information is, however, not far off, as each month the operations furnish further data.

One case which may be quoted to illustrate how the areas containing copper are being extended, is that of the Roan Antelope, the Roan Antelope Extension adjoining it, and the Muliashi area immediately beyond that. The full extent of these three properties is about 10,787 acres, and it covers a total length of over ten miles in a north-west south-east direction. Out of this total length of ten miles, the ore shales have so far been proved by surface trenching and pitting to be mineralised over a length of about seven miles. The actual proving of the ore shales in depth is being done principally by drilling. Beginning at the south-eastern end of the area—that is in the Roan Antelope property—the basin has been drilled in considerable detail over a distance of about two miles, supplemented by extensive underground work, and has been found to contain 30,000,000 tons of commercial ore, with probabilities that additional drilling in the area will add materially to that tonnage. Beyond these two miles, a line of holes has been drilled along the south limb of the basin for a further distance of about 2½ miles, and every drill hole has shown commercial ore.

Coming to the Roan Antelope Extension area of 2675 acres, information recently received from Rhodesia states that borehole No. 9 entered sulphide ore at 560ft. From 560ft. to 562·7ft. the assays gave 3·20 per cent. copper, and from 562·7ft. to 569ft. 5·40 per cent. copper. This gives an average over 9ft. of 4·70 per cent. sulphide copper, and the hole continues in copper, the thickness often running over 30ft. This hole is 4000ft. north-west along the strike from borehole No. 1 on the Roan Antelope Extension, and 5000ft. from the Muliashi property. Borehole twenty-eight, which is the last hole to the north-west on the Roan Antelope, is about 11,000ft. south-east along the strike from No. 9 Roan Antelope Extension. This hole indicates the continuity of payable ore over a distance of about six miles, with the probability of further work

extending it still further to the west into the Muliashi property, which has an area of 6000 acres. This almost certainly very considerable extension of the area numeralised—with ore of commercial value—is but one instance out of a number that could be quoted to show how rapidly the known area of the Northern Rhodesian copper field is being increased. As far as the Roan Antelope is concerned, a scheme for providing over £2,000,000 for its equipment was unanimously approved by the shareholders at the end of April, and the chairman foreshadowed the treatment of 2,000,000 tons of ore per annum for years to come, and added that there was every probability that, ultimately, operations would be extended to far in excess of even that rate.

The Vice-president of the American Metal Company, which is largely interested in the mine, estimated last year that within three years the mine should be able to produce at least 15,000 tons of copper per year. With metal at only 7d. per pound he budgeted for distributable profits of £920,000 a year, plus £155,000 more for every halfpenny extra in the price obtained for the copper. In even less time than three years the N'Kana Mine and the N'Changa Mine should be producing as much each, and the capital required to bring each of these mines to the production stage and equip them with plant is already secured. Among other copper properties likely to become as great as any, the Kansanshi, Lunsemfwa, Mimbula, Chifumpa and Loangwa might be cited. The Secretary for Mines (Northern Rhodesia) considers that the prospecting work done by several of the large companies has gone far to show that the folding of the Roan Antelope Mine is to be found repeated on larger scales, in different places and forms, over a very wide area of country just south of the Congo Border, and carrying high values over good widths. "More tonnage mines," he states, "are certain from this quarter."

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Steady Conditions.

IN the iron and steel and engineering trades of the Midlands and Staffordshire conditions remain fairly steady. They show improvement upon the usual state of affairs at this time of the year, and evidences point to a continuance of the existing favourable conditions. True the home demand for iron and steel is fitful, but an increase in consumptive demand in all branches is gradually asserting itself. The weekly meeting of the Midland iron trade in Birmingham was well attended, and the tone was decidedly strong. The position, especially in the raw iron department, is being closely watched, and native material is the subject of inquiry almost to the exclusion of foreign iron and steel. Midland iron and steelmasters are moderately busy, as are most of the heavy engineering industries in the district.

Pig Iron Sales.

Though there is an increased consumptive demand for pig iron, the buying movement is not quite so strong as it was a week ago. This is accounted for by the fact that consumers, foreseeing the trend of events and realising the difficulties in the way of expanding production of raw iron, have added considerably to their commitments. Many Midland furnaces have booked up their output over the third quarter, and are not prepared to move in advance of that. Indeed there are rumours of further advances in prices. Not only has consumption increased in this area, but the stringency of supplies in Cleveland has resulted in the sale of considerable quantities of Northamptonshire pig in that area. Midland furnacemen and merchants have received a good deal of inquiry from the North-East Coast, and have disposed of substantial tonnages of iron. Prices are very firm at £3 10s. for Northamptonshire foundry, and £3 13s. 6d. for Derbyshire delivered to Black Country stations. Premiums are stated to have been paid for certain makes, but the statement lacks confirmation. Smelters' order books would justify increased production, but so far there has been no addition to the number of furnaces operating in this district. Possibly this is due, in a very large measure, to the difficulty in securing adequate supplies of coke at the right price. Many furnacemen have contracted for ample supplies at the current rate of output, but with the make of pig iron increasing faster than the production of coke the dangers of a coke stringency are increasing. Coke is obtainable at date at 14s. 6d. per ton at ovens, and ovenmen are hard pressed to meet the demand.

Steel Activity.

Activity in the steel trade is mostly concerned with the semi-finished department. Orders for finished steel are increasing very slowly, and with prices firmly established, little interest is evinced just now in this branch. Structural engineers in this area hold few large contracts, and for those in hand they secure supplies from week to week. Special engineering steels and material for the wagon-building establishments are in regular request. The mills producing sections, joists and plates are fairly employed, the aggregate of business coming through about maintaining order books in a healthy condition. Makers of bars and billets are in a good position, and values are upheld. Some makers of billets can afford to ask a good deal more than the minimum of £6 12s. 6d. Welsh billets are still obtainable at £6 10s., efforts to raise the price having proved unavailing. Birmingham merchants report more eagerness on the part of continental houses to do business, and some offers of large supplies have this week been received. For 2in. billets shippers want £6 7s. 6d. delivered, and sheet bars are quoted at £6 5s. to £6 7s. 6d. These prices are much too high to be attractive, and it is in but few directions that imports are being seriously considered in this district. English steel tube strip is selling in fairly good quantities at recent rates.

Finished Iron.

Demand remains fairly steady in the Staffordshire iron trade, but small consignments are the rule. Marked bar mills are running regularly, and makers are able to maintain prices at £12 per ton. Competition in the Crown bar department persists, and Staffordshire makers have difficulty in keeping up the price standard. Consumers assert that they are able to buy at £9 17s. 6d., but makers generally maintain that the £10 figure is being adhered to. Outside districts are offering supplies at as low a figure as £9 15s., but the material is said not to be of the same high standard as bars produced in Staffordshire. Makers of nut and bolt iron, faced with severe competition from the Continent, are but poorly employed. Belgian No. 3 iron purchased at £7 2s. 6d. and even less is coming regularly into the district. The Darlaston nut and bolt trade is, at date, none too active. Bright bolts and nuts are in fair demand, but the black side of the trade is dull. Wrought iron gas tube strip is now generally quoted £11 per ton, and producers report no falling off in demand as the result of the price increase.

Galvanised Sheets.

The galvanised sheet mills are making a fair and regular output, and inquiries are on the increase. With the exception of India all the overseas markets are buying better. The total exports last month were well above those for April, though India took some 10,000 tons less than in the previous month. Twenty-four gauge corrugated sheets are quoted £13 12s. 6d. to £13 15s. per ton f.o.b. Liverpool. Prices of lighter gauge sheets are unaltered.

Scrap.

There is no material change in the scrap market on the week. While there is no scarcity there is no abundance, and sellers are able to maintain prices at recent levels. Some users in South Wales have been testing the market for supplies at £3 16s., but Birmingham sellers want £3 17s. 6d. minimum. It is not so long ago that Welsh buyers would have been glad of supplies at £4. The market tension has apparently been overcome.

Mining Engineers and Haulage.

At a general meeting of the South Staffordshire and Warwickshire Mining Engineers, in Birmingham on Monday, the principle business was a consideration of methods of underground haulage and conveying. Mr. C. F. Jackson, the President, opened the subject with some remarks on the possibilities of electrically-driven locomotives for the haulage of coal to the pit bottom. There were, he said, two types of these locomotives, those which drew the power from a bare overhead wire, and those which were run from accumulators. He dealt with the obvious risks of bare wires and pointed out the disadvantage of the use of accumulators which was that the system could not deal with the gradients possible of negotiation by the bare wire system. For the accumulator system a comparatively flat haulage road was necessary. There was no doubt, said Mr. Jackson, that by means of the bare wire many advantages could be gained, especially in facilitating men getting quickly to their work when they had descended the shaft. The cost of installing electrically-driven locomotives of either type was not serious when compared with that of installing and maintaining the more cumbersome haulage system in common use in this country. It was estimated that a locomotive run from batteries could be put in at a cost of £1811. He did not suggest the use of the bare wire system in this country, but thought a case could be made out for the use of the accumulator-driven type of locomotive on level haulage ways. Mr. L. Holland, in a paper, dealt with the possibilities arising from the perfecting of the endless rope-system.

Praise for British Steel Nails.

Midland industrialists will be interested to learn the opinion expressed by Mr. H. J. Skelton, of the iron and steel, tin-plate and metal merchant section of the London Chamber of Commerce before the Standing Committee of the Board of Trade regarding British steel nails. "At the present time," he said, "there are no nails in the world, with one possible exception, equal to the English products." He asserted that we were gradually driving the foreigner out of the market, and added that it was only during the last four or five years that there had been foreign competition in the manufacture of the finer types of nails. He recalled the "terrible scandal" of fifty years ago regarding the sweated labour of women and children in the hand-made nail trade of the Midlands. "The days of hand-made nails," he said, "are happily gone for ever."

Coal Distillation Plant at Cannock.

What is stated to be the first low temperature coal distillation plant in Staffordshire is now in course of erection at Leacroft, Cannock. The Vandergrift process is, I understand, to be used, and it is estimated that at first 1400 tons of local coal will be required weekly, and that eventually, when the initial plant has been extended, 1000 tons a day may be needed. From the coal, benzol, toluol, light and heavy oils and tar are to be extracted. After extraction a smokeless fuel for ordinary grates will be left.

Warwickshire Miners' Wages.

In view of the fact that the Mines Department, at the instance of the Miners' Federation, has intervened in the matter of the wages to be paid at the three Warwickshire pits, referred to in this column last week, the Joint Wages Board of the county, which last week-end considered the question, postponed its decision, and it has been agreed to suspend the notices for a fortnight. The Mines Department has invited a deputation representing the Warwickshire Colliery Owners' Association to meet it to discuss the situation. The three collieries concerned having retired from membership of the Association are endeavouring to arrange that their case should also be put before the Mines Department.

Slump in Cannock Chase Coal Trade.

Demand for coal in the Midlands and Staffordshire has fallen away considerably of late, and trade conditions in the coalfield of Cannock Chase are very sluggish. Most of the pits are working only three days a week, and collieries have considerable difficulty in disposing of even this limited output.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Seventeen Storeys.

AN immediate start is to be made on the work of constructing a huge seventeen-storey building near Oxford-street, Manchester, for Tootal Broadhurst Lee and Co., Ltd. A good deal of discussion took place as to the advisability of such a building when the application to proceed with the work was before the Building Committee of the Corporation some time ago, but eventually permission was granted. It will certainly be far and away the tallest building in the city, and the claim is made that it will be the tallest in the country. When completed, it will be 210ft. high, and will easily dwarf the new offices in King-street of the Manchester Ship Canal Company, which, with its mere nine storeys, for the time being holds its head much higher than any other building in Manchester. The contract for the constructional work has been placed with Banister, Walton and Co., Ltd., Trafford Park, and about 3000 tons of British steel will be used. The architect is Mr. H. S. Fairhurst, of Manchester, who was also responsible for the Ship Canal building. The first ten storeys, of a height of 96ft., are expected to be completed in six months.

£524,000 on Electricity Extensions.

During the year ending March 31st last, new capital outlay on the Manchester Corporation electricity undertaking, according to the annual report just adopted by the Electricity Committee, amounted to £525,656, mainly in respect of extensions at Barton power station and the laying of mains to meet the additional demands of consumers. Altogether, the capital outlay and assets amount to £11,369,693, and loan debt stands at £5,693,854. The net profit on the year's trading was £80,892, equal to 0·79 per cent. on the capital outlay, and £35,548 was used, with the sanction of the Electricity Commissioners, to meet capital outlay instead of raising loans. Sales of current showed an increase in volume of 6 per cent. and in value of 5 per cent. The consumption of coal during the year was 339,970 tons at an average cost of 166d. compared with 174d. in the previous year.

Blackburn and the Central Power Scheme.

It is officially announced that the Central Electricity Board has reached an agreement with the Blackburn Corporation concerning the future of the Whitebirk generating station, the construction and equipment of which has cost about £1,000,000. While the Board cannot recommend, through a legal difficulty, its inclusion as a selected station, it is prepared to pay 60 per cent. of the capital charges, involving an estimated saving to Blackburn of £20,500 a year up to 1935.

Arterial Road for Manchester.

It is understood that proposals for the construction of a first-class arterial road, running about 100 yards from, and parallel with Market-street, Manchester, which is the centre of the city and the busiest thoroughfare, will shortly be placed before the authorities.

Higher Profits.

Another engineering company to show improved results for the past financial year is Mirrlees, Bickerton and Day, Ltd., of Stockport. For the twelve months to the end of March, the net profit amounted to £31,895, compared with £20,162 in the previous year, and a dividend of 7 per cent., against 6 per cent., is to be paid on the ordinary share capital. The sum of £8504 is carried forward.

Non-ferrous Metals.

Comparative steadiness with, however, slight losses on balance for the week, has again been a feature of the non-ferrous metals market in most sections. In the case of copper, buying interest for consumers has not been particularly active, although a fair amount of speculative buying has been in evidence. The metal has experienced its ups and downs during the week, but current values are only a few shillings below those ruling a week ago, although at one period the loss was heavier. In spite of the fact that prices at the moment of writing have, on balance, lost ground to the extent of about 15s. a ton, tin has had a more "bullish" week than for some time. Dealings in the metal have been rather extensive, and at one time there was a sharp rise in prices, with, however, the inevitable reaction due to profit-taking. Lead has maintained its advance of last week, and values are pretty much the same as before. On the whole, a not unsatisfactory volume of business had been done. There has been no improvement in the demand for spelter and, in the aggregate, transactions in the metal during the past week have only been moderate. At the time of writing, however, quotations for the metal are only fractionally lower than they were a week ago.

Iron and Steel.

On the whole, conditions in the iron and steel markets locally are not unfavourable. Expectations have been freely expressed of an early rise in prices of Derbyshire, Staffordshire, and other Midland varieties of foundry iron, and consumers have shown some anxiety to add to tonnage they already have ordered. Except at premium

prices, however, sellers have refrained from committing themselves further ahead than the end of September. Deliveries of iron to Lancashire foundries are maintained at a relatively satisfactory level, although a seasonal falling off is expected on account of the approaching holiday season. For delivery in the Manchester area, Staffordshire iron is at 73s., Derbyshire at 72s., Middlesbrough at about 85s., Scottish at from 91s. to 92s., and hematite at 86s. 6d. Scarcity of scrap is hampering operations in finished iron. The Lancashire Bar Iron Association, while adhering to the 5s. increase in Crown bars, which are quoted at £10 15s. per ton, has cancelled the advance in second quality material, the revised quotation for which is now £10. Specifications for constructional varieties of steel have been circulating rather more freely during the past week, and a fairly steady demand against contracts is being experienced for locomotive boiler and frame plates. Inquiry for general plates, however, is on the quiet side. Acid boiler plates are at £9 17s. 6d. per ton and basic kinds at 5s. less, with ship plates at £8 17s. 6d., joists at £8 2s. 6d., re-rolled bars at from £8 5s. to £8 10s. according to quantity, and large diameter bars at £9 2s. 6d.

BARROW-IN-FURNESS.

Hematite.

The position in the hematite pig iron market is unchanged. Makers are well booked for iron, and there is every sign of the demand continuing through the summer. The home demand is steady for ordinary qualities, and business is firm in special qualities. The American and continental business, which is mostly in special qualities, is maintained, and is likely to persist. The local demand on steel account continues. Iron ore remains steady, and the demand by outside smelters is about the same. Foreign ore is in steady demand. The steel trade is not very bright, but Barrow keeps going, though not on full production. The Siemens plant, rail, merchant, hoop and bar mills are engaged at Barrow. Hoops are experiencing a very steady trade, mostly on overseas account.

The Future.

After the launch of the British submarine at Vickers-Armstrongs last Friday, Commander Craven, the local managing director, said that they had at present 13,394 employees, but unfortunately they had three large ships and four submarines leaving before the end of the year, and unless they were very fortunate indeed they were heading for rather a serious winter. There can be no doubt about the position in view of the fact that there are no big vessels to fill the fitting out berths, which will be vacated by the Orient liner and the two large repair vessels for the Admiralty this year, and it will mean many men being stopped.

SHEFFIELD.

(From our own Correspondent.)

The Local Steel Trades.

THE condition of the various branches of the steel trade in Sheffield and district varies little from what has been reported in recent weeks. While some sections are busy, others are not, but there is a growing feeling of confidence in the future. The fact that the production of pig iron is being increased suggests an optimistic feeling on the part of makers and consumers alike. There are at present forty-three blast-furnaces in operation on the North-East Coast, as compared with thirty-one at the beginning of the year. Preparations are being made for starting four more, and it appears probable that the total will be brought up to fifty by the end of the year. The number of steel furnaces in operation in this district has not altered for some time. There is still a large output on the basic side, but the inquiry for acid steel shows no increase. The tonnage of this material going into railway work is much below the normal, owing to the very restricted orders from the home companies. Price movements in iron and steel are being watched with close attention. Manufacturing costs have risen recently, and there is some fear that this may lead to a revival of severe foreign competition. The manufacture of special lines continues to provide valuable employment for a number of firms. A good deal of remodelling of shops and stores is going on in the country just now, and is calling for a large tonnage of structural iron. There is also considerable activity in the section devoted to the supply of weigh-bridges for use in markets, railway depôts, and docks in this country and the Near East.

Aircraft and Other Steels.

For non-corrodible and stainless steels, to be used for a variety of engineering purposes, there is a constantly expanding demand. The automobile industry continues to be one of the best feeders of Sheffield trade, calling for many alloy steels and steel parts, and a good trade is also being done in aircraft steel, although the tonnage of this is not very large as yet. The manufacture of steels for the seaplanes which will take part in the race for the Schneider Trophy has received a good deal of special attention of late. These steels are used for crank shafts, connecting-rods, and other highly stressed and important parts. One of the firms which will be worthily represented in the Schneider contest is Vickers-Armstrongs, Ltd., now part of the English Steel Corporation, which is making important contributions to the machines at its River Don Works, Sheffield.

Steel Works Reconstructions.

It is cheering to learn that reconstructions in the steel industry are projected, for it shows a healthy view of the future on the part of the trade. This remark is based on a sentence in the annual report of Davy Brothers, Ltd. The firm had a bad year, losing £6300, owing to insufficiency of business. "Nevertheless," the report says, "a fair proportion of foreign business has been obtained, though necessarily at very close competitive prices." It adds that "the present position is, however, decidedly more favourable, as considerable orders have been secured during the last two months, and reconstructions in the steel industry which have been decided on will lead to a good deal more work in the future." Another note of optimism was struck by the chairman of William Cooke and Co., Ltd., at the annual meeting. This company is engaged in the manufacture of bar iron, horse shoes, wire ropes, and wire rods, and is another of those which did badly last year, the loss amounting to upwards of £17,000. The chairman, however, expressed the opinion that the position to-day, speaking generally, was an improvement on that of a year ago, and he believed the improvement would steadily go on. He was more optimistic than he had been for some time, though his optimism did not lead him to say that the company would make profits from now on. Cooke's are one-third owners of the Templeborough Rolling Mills, Sheffield, which is a very finely equipped establishment, and is at present working well—so well that it has just paid an interim dividend. The importation of wire rods into this country, though still large, has shown a falling off during the last two or three months.

Orders Booked.

A number of orders have come to Sheffield and district firms during the last week or two from Government departments and other sources. The Admiralty is purchasing tool steel from Cammell Laird and Co., Ltd., T. Firth and Sons, Ltd., J. J. Saville and Co., Ltd., Sanderson Brothers and Newbould, Ltd., S. Osborn and Co., Ltd., Watson, Saville and Co., Ltd., A Balfour and Co., Ltd., all of Sheffield, and from W. Oxley and Co., Ltd., Rotherham. The same department has given orders for electro-plate to the Sheffield firms of Fenton Brothers, Ltd., Gladwin, Ltd., William Hutton and Sons, Ltd., Joseph Rodgers and Sons, Ltd., and Walker and Hall, Ltd. The War Office is buying tool steel from S. Osborn and Co., Ltd., and round steel from S. Fox and Co., Ltd., Steel, Peech and Tozer, Ltd., and the English Steel Corporation, Ltd. The Crown Agents for the Colonies have placed orders for crushing and screening plant with E. Allen and Co., Ltd., for pipes with the Stanton Ironworks Company, Ltd., and for steel with J. H. Andrew and Co., Ltd. Another order which Edgar Allen and Co., Ltd., has booked is for points and crossings for the Glasgow Corporation tramways.

Cold Working of Steel.

An interesting new department of Sheffield University, which will be opened on July 6th, is the Cold Working of Steel Laboratory. A few months ago the Worshipful Company of Ironmongers made a grant of £800 per annum to the University for the founding of a research fellowship and two research scholarships for the study of the cold working of metals. With the assistance of the Cutlers' Company and local manufacturers, a laboratory has been founded, and equipped with the necessary plant for the drawing and rolling of steels, and with all the apparatus which will be required for a systematic study of the metallurgical changes involved in the processes, and of the engineering conditions which will give the most favourable results. The laboratory will be opened by Mr. E. A. Ebblewhite, Master of the Ironmongers' Company, who will at the same time receive the honorary degree of Doctor of Laws of the University. Another honorary degree which will be conferred on the same occasion is that of Master of Engineering, to be given to Mr. Frederic Lloyd, a well-known Sheffield manufacturer of engineers' tools.

Barnsley's New Waterworks.

The county borough of Barnsley has just completed the construction of a new reservoir in the hills near Penistone, which was opened last week, and has started work upon another. The two schemes involve an aggregate expenditure of £560,000. The completed reservoir is the Scout Dike, which has cost £190,000, has a capacity of 165,000,000 gallons, and will yield 700,000 gallons a day, which will be used as compensation water, thereby freeing for public consumption an equal amount which has hitherto been drawn from Ingbirchworth reservoir. The embankment at Scout Dike is 1200ft. long, rising 42ft. from the old stream level. A trench filled with concrete has been taken down below the ground level to watertight strata, and there is a puddle clay core wall to the top of the bank. The reservoir on which work has now been started is at Royd Moor, and is being constructed for ordinary storage purposes. It will have a capacity of 180,000,000 gallons. Under its Act of 1927 Barnsley Corporation has the power to take from the tributaries of the river Don between Hazlehead and Dunford Bridge, all surplus above a minimum flow each day, and the available yield over periods of dry weather will be 1,000,000 gallons daily. This water, after abstraction from the streams, will be conveyed by an aqueduct to the Royd Moor reservoir, whence it will be taken by means of a pipe line along and past Scout Dike over the hill to Hoylandswaine, where it will meet the existing line of pipes from Ingbirchworth. Both will discharge into the new service reservoir at this point. The Act also provides for the enlargement of the additional pipe line, authorised by the 1923 Act, from Hoylandswaine to Barnsley, with a further service reservoir at Champany Hill. The total estimated cost of this scheme is £370,000. The bank at Royd Moor will have a length of 1300ft., and will rise to a height of 75ft. above stream level. The work is expected to be completed by 1934. It will be carried out, as that at Scout Dike has been, by direct labour under Mr. J. R. Fox, M. Inst. C.E., the waterworks engineer and manager at Barnsley, whose representative on the spot is Mr. D. L. Serpell, Assoc. M. Inst. C.E. The problem of future water supplies is still before the Barnsley authorities. The work now in hand will only meet the needs of the next few years, and the Chairman of the Water Committee has strongly urged the importance of county or national action with regard to the acquisition of further resources for water authorities.

A Derbyshire Sewage Scheme.

The Shardlow Rural District Council is proposing to carry out a sewage scheme for Chellaston, near Derby. A Ministry of Health inquiry has been held with regard to an application for powers to borrow £15,280.

Cutlery and Plate.

There is little change to report in the condition of the cutlery and plate trades, in which, apart from special orders for hotel and steamship equipment, business is far from brisk. An exception to the general rule is the wafer blade branch, which is very actively employed. A report from the United States Department of Commerce indicates that Sheffield is beaten by the United States and Germany in the sale of safety razors and blades to Turkey. The market in that country is in its early stages, and the feeling in Sheffield is that the quality of the locally produced article is bound in the long run to have its effect, and that, with a sales campaign that includes attractive literature in the native language, it will be possible to demonstrate the superiority of British goods. The Marking Order for imported cutlery ware came into force on June 21st. Its effect is that many articles of cutlery must not be imported into the United Kingdom or sold after they have been imported, unless they bear an indication of origin.

NORTH OF ENGLAND.

(From our own Correspondent.)

Iron Trade Activity.

THE outlook in the North of England iron trade is distinctly encouraging, and there is every probability of a steady increase in the number of blast-furnaces in operation during the next three months. In addition to the two furnaces started last week by Palmer's Shipbuilding and Iron Company, Ltd., at Jarrow, two more furnaces are to be rekindled at the Linthorpe Ironworks of the Dinsdale Smelting Company next month, while the South Durham Steel and Iron Company, Ltd., West Hartlepool, has decided to put two furnaces into operation, one in August and the other in October. The Linthorpe works have been idle since the coal strike of 1926, and the Seaton Carew works have been idle for a longer period. The Seaton works will be engaged in the production of basic iron for the steel works. Other firms are also seriously considering the possibility of increasing the number of furnaces blowing, and it is quite possible that before the end of the year some fifty furnaces will be working on the North-East Coast, a larger number than has been in commission since the depression commenced eight years ago. At the moment the ironmasters are seriously handicapped in extending their production owing to the shortage of coke and iron ore, but it is hoped that these difficulties will be overcome in the near future.

Cleveland Iron Trade.

Conditions in the Cleveland pig iron trade are unchanged, and there seems little likelihood of the stringency in supplies being relieved for some time to come. The supply of iron falls considerably short of current needs, and production cannot be appreciably enlarged because of the scarcity of raw material. An increased output of Cleveland ironstone and a greater production of coke are essential to enable ironmasters to put more blast-furnaces into operation. Scarcity of suitable labour prevents idle ironstone mines being reopened, and coke makers cannot be expected to put more ovens into action so long as it is substantially more profitable to sell the coal than to convert it into coke. Cleveland ironmasters continue to hold aloof from the market. They are unable to accept orders for delivery before October, and customers fail to tempt them to quote for supply so far ahead. Stocks have long since disappeared, and the only Cleveland pig iron available for the market is what can be spared from the small quantities merchants have yet to receive in fulfilment of unexpired contracts with producers. Merchants report that continental customers will not pay anything like ruling rates, but any iron that comes on the market is promptly purchased for home consumption. No. 1 Cleveland foundry iron is 75s., No. 3 G.M.B. 72s. 6d., No. 4 foundry 71s. 6d., and No. 4 forge 71s.

Hematite Pig Iron.

East Coast hematite pig iron is not so scarce and is still obtainable at comparatively low figures, ordinary qualities being on sale at only a shilling or two above the price readily paid for No. 3 Cleveland, whereas the normal pre-war difference was 8s. to 10s. Hematite producers are fairly well placed as regards work. They have no prompt parcels to dispose of, and are sold well ahead. Merchants have, however, rather large speculative purchases falling due, and most of this iron comes on the market. A moderate business is passing with home and continental consumers, and prices are a little stronger. Buyers now experience difficulty in placing orders for ordinary qualities at 74s., and up to 74s. 6d. is asked. No. 1 grade is at a premium of sixpence.

Ironmaking Materials.

Transactions in foreign ore are necessarily on a very limited scale. Sellers are not in a position to offer large quantities, and consumers have heavy contracts made over lengthy periods, so that they are not keen to negotiate for further supplies. Prices are strengthening. Best Rubio at 23s. 6d. per ton c.i.f. Tees is recognised as the basis of market quotations. Good Durham blast-furnace coke is now up to 20s. 6d. per ton delivered at the works, and even at that figure supplies are so scarce that plans for restarting certain ironworks have had to be postponed.

Manufactured Iron and Steel.

There are no new features of moment in the manufactured iron and steel trade. Manufactured iron firms have good order books and report a few new orders coming to hand, while makers of semi-finished steel are

busy and likely to continue so. Finished steel producers are turning out a lot of work. Quotations are steady.

New Shipbuilding Orders.

The Furness Shipbuilding Company, Ltd., Haverton Hill, has received an order to build a Diesel oil-tanker of 16,000 tons deadweight for Danish owners. The vessel will be built on the Isherwood frame system, and will be one of the largest built on the River Tees. Delivery is to be made in July, 1930. Smith's Dock Company, South Bank, is to build a self-trimming collier for a London firm, and a collier has been ordered by a Dutch firm of owners from the Cowpen Dry Dock and Shipbuilding Company, Ltd., Blyth.

The Coal Trade.

It seems to be the destiny of the Northern coal trade to receive set-backs just when prospects are brightest. The continued dearth of prompt steamers is another of those unwelcome experiences which militate against an otherwise favourable market. Even if the absence of certain sizes of boats is placing collieries in a difficult position, there is no disposition to reduce prices. If concessions were made, they would not help to find tonnage, so the only alternative for producers is, apparently, to work short time until the supply of steamers improves. Large boats are not scarce, and more of them may be attracted to the shorter coal voyages on account of the unexpectedly dull condition of the grain-carrying trades. Consumers abroad who have stipulated for two cargoes in the smaller boats, which are now so scarce, may, if the port is suitable, take both cargoes at one time in a large boat. This would help the situation. Another helpful factor will be the rapid delivery by shipbuilders of new vessels ordered earlier in the year. In the meantime, and until the position is relieved, several pits are likely to be put on short time through inability to get loaded wagons cleared. Fitters of every description of coal, report well filled order books, both prompt and for all July, and whilst prompt supplies are offered freely, this is solely due to merchants being unable to take out their specified quantities. On the other hand, whilst buyers inquire freely, they also cannot secure tonnage and are therefore not able to take advantage of the general position. Holders of coal have just to mark time, and they quote steadily at full recent prices, and special discounts can only be obtained under individual circumstances. Best qualities of Northumberland steams are a good forward market at 15s. to 15s. 3d., and Tyne primes command 14s. 6d., steam smalls are steady at 9s. 6d. to 10s., and good ordinaries at 9s.; Durham steams remain steady at 18s. for best and large kinds and 12s. to 12s. 6d. for smalls. Gas coal quotations are maintained, 16s. 6d. being indicated for bests, and 16s. to 16s. 3d. for seconds. There is plenty of business in coking coal, and the necessity for boats to carry on the export trade to Germany, France and Belgium is becoming acute, so that clearances are slow. In spite of this, sellers adhere to full recent prices—16s. 6d. to 17s. for good unscreened coking, and 16s. to to 16s. 3d. for smalls. Bunkering coal is at steady prices also, bests and superiors being 17s. to 17s. 6d., and ordinaries at 16s. to 16s. 3d. There is a firm general tone in the coke market, and manufacturers have good order books. Consequently, gas coke, which is in limited output, is firm at 22s.; patent foundry coke is steadily priced at 19s. 6d. to 21s. for ordinary grades, and 23s. to 26s. for specials. Beehive coke continues at around 28s.

SCOTLAND.

(From our own Correspondent.)

Quiet Markets.

THE general position in the steel, iron, and coal markets is unchanged, and nothing has taken place calculated to inspire confidence with regard to the possibilities of improvement in the near future. Buyers on all hands are acting with extreme caution, and practically nothing but immediate requirements are entertained. Clyde shipbuilding yards have far too many unoccupied berths for the health of the industry and producers of shipbuilding materials, and it is to be hoped that new orders will show a decided increase within a short time. It is known that inquiries have been fairly numerous, but doubtless the higher costs hamper the placing of orders.

Steel.

In the heavy steel department the turnover has been a shade better, but deliveries to Irish consumers have been impeded by the labour troubles in Belfast. The section mills have been comparatively well employed. About this time it is usual to anticipate requirements over the annual "fair" holidays, but so far there has been no sign of any rush. Steel sheets are in somewhat better demand, and prospects have improved to some extent in view of the fact that the Indian market may open up within a few weeks.

Tubes.

Conditions in the tube trade are still good. Plants are heavily engaged and outputs very large. As a result, those mills depending mainly on the demand for tube strips are almost fully employed at present.

Iron.

Bar iron is a very dull market, and there is little prospect of immediate improvement. Prices are unchanged. In the steel re-rolling department continental competition is becoming more severe, heavy deliveries from abroad being now the rule. Home prices are maintained round about £8 per ton, with export in the region of £7 15s. per ton. It is reported that some orders are on hand for iron tube strip for shipment to Canada.

Pig Iron.

Pig iron makers have made little, if any, progress within the past few weeks. Hematite is in steady, but quiet demand, while foundry qualities are doing very little. Minimum prices are unchanged at 78s. hematite, 77s. No. 1 foundry, and 74s. 6d. per ton No. 3 foundry—all for home delivery.

Scrap.

The scrap position continues to ease. Supplies are freer and heavy steel is quoted about 75s. and heavy basic 70s. per ton.

Coal.

Business in the coal trade has been rendered still more difficult, owing to a shortage of shipping tonnage. It is particularly distressing that there should be this shortage, when the Fifeshire collieries, depending as they do on the export trade, are comparatively well booked, and, in fact, in some cases oversold. As a result of this lack of tonnage, idle time, which is prevalent in the West of Scotland and the Lothians, is spreading to Fifeshire also. Most qualities of large coal are greatly in need of orders, and any buyer with prompt business to place could, in all probability, secure advantageous terms. Washed materials are in rather scarce supply, and as a rule prices are firmly maintained. Aggregate shipments amounted to 250,829 tons, against 248,001 tons in the preceding week and 218,302 tons in the same week last year. Home demands are at their lowest and consequently afford no relief to the collieries for the lack of export business.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Conditions.

IT cannot be said that there is any material improvement in the conditions prevailing in the steam coal section at the moment, though the outlook is viewed in some quarters as being a shade brighter. Shortage of orders is not altogether the cause of the comparative quietness ruling, as the inquiry for all grades of coal is quite good. It is rather to be feared that the inadequacy of prompt tonnage has more to do with the situation. Many exporters are experiencing considerable difficulty in securing the particular tonnage suited to their requirements. It is a matter for some surprise to find, in the circumstances, that shipments are so well maintained. The total for the week ending 21st inst. came to nearly 538,000 tons, which compared with rather more than 524,000 tons for the preceding week. At the same time it should be noted that at the end of last week there were no less than thirty-one idle tipping appliances at the various docks, while only one steamer was waiting. Arrivals of steamers over the week-end improved the position somewhat, and on Tuesday the report was that the number of idle appliances had been reduced to sixteen. It is impossible to be any too confident regarding the immediate future, because of the doubts which exist in respect of the tonnage supplies available. Returns show that the amount of chartering has fallen below the average of late, so that if tonnage is not put at the disposal of the collieries, the latter will have difficulty in maintaining regularity of work. While business for prompt shipment leaves much room for expansion, there is no doubt that a fair amount of business has been done for delivery ahead. In addition to substantial orders completed for South America, it is reported that French railways have bought about 120,000 tons of coals for delivery over the next two or three months. The M.Z.A. Railway of Spain have also purchased about 25,000 tons of steam coals, and other business has been done for Irish buyers and for Belgium for delivery over the remainder of this year.

South Wales Miners' Affairs.

The report of the South Wales Miners' Federation shows that the average membership last year was 59,858, as compared with 72,981 for 1927 and 136,250 for 1926. Revenue from contributions and political levy totalled £45,424, as against £55,331 in the previous year and £538,138 in 1926, which was the strike year. Expenditure last year came to £40,947, compared with £45,719 the previous year. The excess of contributions over expenditure was £4477, as against £9612 in the preceding twelve months. The annual Conference of the Federation was held at Cardiff at the end of last week, when, as usual, a number of resolutions were passed. As regards hours of labour, a motion was adopted instructing the Executive to take the necessary action to ensure the early restoration to the workmen of those conditions obtainable previous to the 1926 lock-out. A resolution was adopted in which the Conference declared itself in favour of, and pledged itself to take every action necessary to secure, nationalisation of mines and by-products, though on this occasion the words "without compensation" were omitted. With regard to the question of the new agreement, the extreme section had tabled a resolution which called upon the M.F.G.B. to convene an immediate Conference to prevent the renewal of district agreements, and to endorse a plan of action in preparation for a struggle of a national agreement, by strike action if necessary, at the end of the year. This resolution was defeated, and another was adopted in which the Executive Council was instructed to get into touch with other county organisations of miners and the M.F.G.B. with a view of securing a national agreement when the district agreements terminate at the end of the year.

Docks Traffic.

G.W.R. Company returns for the four weeks ended June 9th last, of seaborne traffic at the docks in this district under its control show a total of 2,801,333 tons, which compares with 3,084,053 tons for the four weeks ended May 12th. Imports totalled 399,865 tons, as against 377,505 tons, which was an improvement, but exports amounted to 2,401,468 tons, as against 2,706,548 tons. Taking the figures for the whole of this year to June 9th, imports and exports combined aggregate 16,495,659 tons, as compared with 15,436,794 tons for the same period of last year.

Cambrian Combine Collieries.

So far nothing official has been disclosed regarding the tenders submitted for the properties of the Cambrian Combine. It is, however, understood that only two or three offers were received by the liquidators, and that these are disappointing and much below what they expected. The report in coal market circles is that the highest tender has been submitted on behalf of a group previously associated with the Combine.

Tin-plate Trade.

The report is current that substantial progress has been made in regard to the establishment of a new sliding scale to govern the wages in the Welsh tin-plate industry. The old sliding scale was based on a selling price of tin bars of £7 10s. per ton, but as the selling price has remained under that figure for a considerable time, it has been inoperative, and certain *ex-gratia* bonus payments have been made to the workmen. The Joint Sub-committee has been discussing the matter from the point of view of the base being calculated on the selling price of tin-plates and tin bars, and it is understood that they have reached the stage of being able to make certain recommendations to the Sliding Scale Committee.

Current Business.

The tone of the market continues quiet and without any special feature, except that prices are firm for smalls and all descriptions of sized coals. This is largely due to the fact that the inquiry for large coal has been restricted and inadequate, with the result that many collieries, except a few producing the best qualities, have not been able to maintain full work, which means that the output of smalls and sized coals has been reduced. Nominally, prices of all coals are unaltered. Coke moves off freely and there is no change in patent fuel, while pitwood supplies are not so heavy, and the tone of this market is very steady at 28s. to 28s. 6d.

CONTRACTS.

BIRMINGHAM ELECTRIC FURNACES, Ltd., has received from Morris Commercial Cars, Ltd., an order for an electric box-type carburising furnace complete with "Birlec" four-arm charging machine, turntable, loading trolleys, &c. This furnace, which has a usable hearth 9ft. long by 5ft. wide and a maximum rating of approximately 185 kW at 440 volts, three-phase, will, it is believed, be the largest electric carburising furnace in this country.

THE BRITISH THOMSON-HOUSTON COMPANY, Ltd., of Rugby, has received from the West Midlands Joint Electricity Authority an order for the complete electrical generating plant required for the first section of the new base load power station being erected at Ironbridge on the river Severn. The equipment embraced in the order includes a 50,000-kW—67,000 horse-power—turbo-alternator, three 21,000-kVA outdoor type transformers, 33,000-volt switchgear, and the necessary auxiliary accessories.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

BRUCE PEEBLES AND CO., Ltd., of Edinburgh, ask us to announce that they have appointed Mr. George E. Whitehead, of 102, St. Mary-street, Cardiff, as their representative for South Wales and the counties of Gloucester, Somerset, Devon, and Cornwall.

THE BRITISH DARDELET THREADLOCK (D.D.G.) CORPORATION, Ltd., requests that, in future, all communications should be addressed to its registered offices, 42, Kingsway, London, W.C. 2. Telephone, Holborn 1382; telegrams, "Dardelet Westcent London."

THE HYDRONYL SYNDICATE, Ltd., asks us to announce that it has changed the address of its offices from 317, High Holborn, W.C. 1, to Medway House, Horseferry-road, Westminster, London, S.W. 1. Telegraphic address, "Hydronyl, Sowest, London." Telephone, Victoria 6172 and 6173.

EDGAR ALLEN AND CO., Ltd., of Sheffield, ask us to announce that their London offices have been transferred from 1, Victoria-street, Westminster, S.W. 1, to Artillery House, Artillery-row, Victoria-street, London, S.W. 1. Telephones, 4528 and 9 Victoria. Telegrams, "Allentare, Sowest, London."

DR. R. LESSING, consulting chemist and chemical engineer, asks us to announce that the address of his laboratory has been changed from Southampton House, 317, High Holborn, London, W.C. 1, to 94a, Horseferry-road, Westminster, London, S.W. 1. Telegraphic address, "Pyrophoric, Sowest, London." Telephone, Victoria 6172 (two lines).

THE ASSOCIATED EQUIPMENT COMPANY, Ltd., of Windmill-lane, Southall, Middlesex, asks us to announce that the headquarters of its newly appointed engineer representative in the Argentine—Mr. R. W. Walker—will be at the offices of the A.E.C. Distributors in South America—Agar, Cross and Co., Ltd., Paseo Colon, Buenos Aires.

THE BUREAU OF INFORMATION ON NICKEL, Ltd., asks us to announce that, in order to increase the efficiency of its work, by avoiding overlapping and duplication of activities, it is joining forces with the Research and Development Department of the Mond Nickel Company, Ltd. The title and address of the Bureau have been therefore changed to the Bureau of Information on Nickel of the Mond Nickel Company, Ltd., Imperial Chemical House, Millbank, S.W. 1. Telephone, Victoria 4444. The management of the Bureau will continue to be in the hands of Mr. A. C. Sturney.

CATALOGUES.

WADKIN AND CO., North Evington, Leicester.—Booklet 205 dealing with cross-cutting and trenching machines.

TECALEMIT, Ltd., Mitre House, Scrubbs-lane, N.W. 10.—*Tecalemit News*, May–June issue, and a 1929 catalogue of Tecalemit lubrication systems and accessories.

ADAM HILGER, Ltd., 24, Rochester-place, N.W. 1.—"Professor Coker's Photo-elastic Apparatus for Determining the Distribution of Stress in Structural and Machine Members."

ROBERT BOBY, Ltd., Bury St. Edmunds.—Loose-leaf catalogue No. 52 dealing in some detail with plant for the cleaning, grading, conveying, elevating, sweating, steeping, and kilning of grain and malt.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
(1) Native	19/6 to 21/-
(1) Spanish	24/-
(1) N. African	24/-
N.E. COAST—	
Native	18/- to 21/-
Foreign (c.i.f.)	23/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	3 18 0	—
No. 1 Foundry	3 17 0	—
No. 3 Foundry	3 14 6	—
N.E. COAST—		
Hematite Mixed Nos.	3 14 0	3 14 0
No. 1	3 14 6	3 14 6
Cleveland—		
No. 1	3 15 0	3 15 0
Silicious Iron	3 15 0	3 15 0
No. 3 G.M.B.	3 12 6	3 12 6
No. 4 Foundry	3 11 6	3 11 6
No. 4 Forge	3 11 0	3 11 0
Mottled	3 10 6	3 10 6
White	3 10 6	3 10 6
MIDLANDS—		
(3) Staffs.—	(*Delivered to Station*)	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 11 0	—
" " Foundry	3 13 6	—
(3) Northampton—		
Foundry No. 3	3 10 0	—
Forge	3 6 0	—
(1) Derbyshire—		
No. 3 Foundry	3 18 6	—
Forge	3 14 6	—
(3) Lincolnshire—		
No. 3 Foundry	3 12 6	—
No. 4 Forge	—	—
Basic	—	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 4 6 (*a*), 4 7 6 (*b*), 4 11 0 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. COAST—		
Iron Rivets	11 10 0	—
Common Bars	10 15 0	—
Best Bars	11 5 0	—
Double Best Bars	11 15 0	—
Treble Best Bars	12 5 0	—
LANCS.—		
Crown Bars	10 15 0	—
Second Quality Bars	10 0 0	—
Hoops	13 0 0	—
S. YORKS.—		
Crown Bars	11 0 0	—
Best Bars	11 10 0	—
Hoops	12 0 0	—
MIDLANDS—		
Crown Bars	10 0 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	9 0 0 to 9 5 0	—
Gas Tube Strip	11 0 0	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	10 10 0	10 10 0
Ship Plates, ½in. and up	8 12 6	7 12 6
Sections	8 2 6	7 2 6
Steel Sheets, ¼in.	9 0 0	8 12 6
Sheets (Gal. Cor. 24 B.G.)	13 17 6	13 12 6 to 13 15 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 12 6	—
Angles	8 2 6	—
Boiler Plates	12 15 0	—
Joists	8 2 6	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	8 2 6	—
Soft Billets	6 17 6	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 5 0	—
Light Rails	8 10 0 to 8 15 0	—
Billets	6 15 0 to 9 10 0	—
MANCHESTER—		
Bars (Round)	9 2 6	—
" (Small Round)	8 5 0 to 8 10 0	—
Hoops (Baling)	10 0 0	9 15 0
" (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
" (Lancs. Boiler)	9 12 6 to 9 17 6	—
SHEFFIELD—		
Siemens Acid Billets	9 10 0	—
Hard Basic	9 2 6 and 9 12 6	—
Intermediate Basic	7 12 6 and 8 2 6	—
Soft Basic	7 0 0	—
Hoops	9 10 0 to 9 15 0	—
Soft Wire Rods	8 10 0	—
MIDLANDS—		
Small Rolled Bars	8 7 6 to 8 15 0	—
Billets and Sheet Bars	6 12 6	—
Sheets (20 W.G.)	11 10 0 to 12 0 0	—
Galv. Sheets, f.o.b. L'pool	13 12 6 to 13 15 0	—
Angles	8 2 6	—
Joists	8 2 6	—
Tees	9 2 6	—
Bridge and Tank Plates	8 17 6	—
Boiler Plates	9 17 6	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	18/3 to 18/6
Block Tin (cash)	200 10 0
" " (three months)	203 17 6
Copper (cash)	74 8 9
" (three months)	73 15 0
Spanish Lead (cash)	23 17 6
" " (three months)	23 12 6
Spelter (cash)	26 2 6
" (three months)	25 15 0
MANCHESTER—	
Copper, Best Selected Ingots	78 5 0
" Electrolytic	85 0 0
" Strong Sheets	110 0 0
" Tubes (Basis Price), lb.	0 1 3½
Brass Tubes (Basis Price), lb.	0 1 1½
" Condenser, lb.	0 1 3½
Lead, English	25 10 0
" Foreign	23 17 6
Spelter	26 5 0
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/11 per lb.	
Ferro Tungsten	2/9 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£25 0 0	7/6
" " 6 p.c. to 8 p.c.	£24 0 0	7/-
" " 8 p.c. to 10 p.c.	£23 10 0	6/-
" " Specially refined		
" " Max. 2 p.c. carbon	£36 0 0	12/-
" " " 1 p.c. carbon	£38 0 0	15/-
" " " 0·70 p.c. carbon	£42 0 0	17/-
" " " carbon free	1/2 per lb.	
Metallic Chromium	2/6 per lb.	
FerroManganese (per ton)	£13 15 0 for home; £13 10 0 for export	
" Silicon, 45 p.c. to 50 p.c.	£12 0 0 scale 5/- per unit	
" " 75 p.c.	£19 10 0 scale 6/- per unit	
" Vanadium	13/- per lb.	
" Molybdenum	4/- per lb.	
" Titanium (carbon free)	1/- per lb.	
Nickel (per ton)	£170 to £175	
Ferro-Cobalt	9/4 per lb.	

FUELS.

SCOTLAND.

(*Prices not stable.*)

	Export.
LANARKSHIRE	
(f.o.b. Glasgow)—Steam	13/-
" " Ell	14/-
" " Splint	15/6 to 16/-
" " Trebles	14/6
" " Doubles	13/3
" " Singles	12/6
AYRSHIRE—	
(f.o.b. Ports)—Steam	13/3
" " Jewel	16/6
" " Trebles	13/9
FIFESHIRE—	
f.o.b. Methil or Burntisland—Steam	12/- to 14/6
Screened Navigation	17/6
Trebles	14/6 to 15/6
Doubles	13/6
Singles	12/-
LOTHIANS—	
(f.o.b. Leith)—Best Steam	13/-
Secondary Steam	12/6
Trebles	14/-
Doubles	13/6
Singles	12/3

ENGLAND.

	Inland.	Export.
(8) N.W. COAST—		
Steams		24/- to 25/-
Household		38/- to 51/-
Coke		23/6 to 25/-
NORTHUMBERLAND—		
Best Steams		15/- to 15/6
Second Steams		13/6 to 13/9
Steam Smalls		9/6 to 10/6
Unscreened		13/- to 13/3
Household		21/- to 26/-
DURHAM—		
Best Gas		16/6 to 16/9
Second		16/- to 16/6
Household		21/- to 27/-
Foundry Coke		22/- to 28/-
SHEFFIELD—		
Best Hand-picked Branch	27/- to 28/6	—
Derbyshire Best Bright House	20/- to 23/-	—
Best House Coal	19/6 to 20/6	—
Screened House Coal	17/6 to 18/6	—
" " Nuts	16/- to 17/6	—
Yorkshire Hards	15/6 to 16/6	—
Derbyshire Hards	15/6 to 16/6	—
Rough Slacks	8/6 to 9/6	—
Nutty Slacks	6/- to 7/-	—
Smalls	2/- to 4/-	—
Blast-furnace Coke (Inland)	14/6 at ovens	—
Furnace and Foundry Coke (Export), f.o.b.		20/- to 21/-

CARDIFF— (9) SOUTH WALES.

Steam Coals :	
Best Smokeless Large	19/9 to 20/-
Second Smokeless Large	19/6 to 19/9
Best Dry Large	19/- to 19/6
Ordinary Dry Large	18/- to 18/6
Best Black Vein Large	18/3 to 18/6
Western Valley Large	18/- to 18/3
Best Eastern Valley Large	17/9 to 18/-
Ordinary Eastern Valley Large	17/3 to 17/9
Best Steam Smalls	13/9 to 14/3
Ordinary Smalls	12/6 to 13/-
Washed Nuts	20/- to 23/6
No. 3 Rhondda Large	20/- to 21/-
" " Smalls	15/6 to 16/-
No. 2 " Large	17/3 to 17/9
" " Through	16/- to 17/-
" " Smalls	13/6 to 14/-
Foundry Coke (Export)	26/6 to 36/-
Furnace Coke (Export)	21/- to 23/-
Patent Fuel	20/- to 21/6
Pitwood (ex ship)	29/- to 29/6
SWANSEA—	
Anthracite Coals :	
Best Big Vein Large	33/- to 36/6
Seconds	27/6 to 30/-
Red Vein	23/- to 27/-
Machine-made Cobbles	40/- to 44/-
Nuts	40/- to 44/-
Beans	23/6 to 25/6
Peas	18/- to 19/-
Breaker Duff	9/- to 9/6
Rubbly Culm	10/3 to 10/9
Steam Coals :	
Large	18/- to 19/-
Seconds	17/- to 18/-
Smalls	10/6 to 13/-
Cargo Through	15/6 to 16/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.t. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated. coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate 12/6 joists and 10/- all other materials if home consumers confine purchases solely to British products.

French Engineering Notes.

(From our Correspondent in Paris.)

Tariff Reduction.

THE tendency of French traders to favour some form of European tariff readjustment is accentuating, and it was particularly marked at the annual meeting of the Comité National des Conseillers du Commerce Extérieur de France, which body comprises French commercial attachés abroad, as well as of commercial men who are selected in the various branches to act in a semi-official capcity for the promotion of foreign trade. Special prominence was given to this meeting because it is felt that something must be done to save the country from a possible future commercial and industrial crisis. It was stated at the meeting that the present industrial activity is due to artificial causes, since it depends mainly on public works, and, as the cost of living in France is steadily rising, and prices must inevitably in time reach the world's level, there is a probability of French traders and manufacturers finding themselves excluded from foreign markets. The conclusion of a report upon the situation was to the effect that a common ramification of commercial interests is more than ever necessary to the prosperity of peoples and to the world's peace. Therefore, it is proposed that the leading continental countries should first settle amongst themselves a method for reducing gradually the import duties to a level at which they will facilitate an interchange of goods, and then secure the adhesion of the whole of Europe to the scheme.

Steel Union.

At the meeting of the International Steel Union in Paris it was decided to increase the steel production during the third quarter of the year by a million tons, thereby bringing the total to 32,295,000 tons. The proposal to renew the Cartel for a further period was adopted unanimously, but it was an acceptation of principle, and its furure will depend upon the decision that will be come to at the next meeting in Vienna, probably in September, when the details are to be settled. Germany and Belgium may both claim higher quotas, and German steelmakers insist particularly upon the removal of restrictions upon their exports of steel, while they are also endeavouring to make the existence of the Cartel dependent upon an international sales' organisation. Last week, also, there was a meeting in Paris of the International Rail Union, at which, contrary to the demands of some British and German makers who wanted to advance them 2s. 6d. a ton, it was decided to make no change in the prices of rails.

Shipbuilding.

During the series of visits they are making to home and foreign ports, the members of the Commission formed by the Association des Grands Ports Français, were received at the shipyards of Messrs. Worms et Cie. by Monsieur H. Worms, who profited by the occasion to describe the situation of the home shipbuilding industry which, he said, was suffering from a number of adverse conditions. He claimed that, in ship design and construction, the French could challenge comparison with other countries, but that they are hampered by the cost of shipbuilding, and by the lack of specialised workmen, although the latter drawback can be remedied when the shipyards are assured of employment. The great difficulties are the high cost of materials and the heavy charges which are being further increased by the new social legislation, and if shipbuilders, who are so far away from the sources of iron and steel supply, have to pay more than builders abroad, the situation could nevertheless be improved by a reduction in the freights on shipbuilding material. In appealing to the Government to help the shipbuilding industry and to shipowners to place their orders in French yards, Monsieur Worms stated that the prosperity of shipbuilding was essential to the country's welfare and to its reputation abroad. While there is some ground for the complaint of Monsieur Worms, it is certain that the situation of shipbuilders has undergone a marked improvement during the past few months. Although the number of merchant ships launched in France has been small, the tonnage increased from 44,335 tons in 1927 to 81,416 tons in 1928, and since then there has been a steady increase of shipbuilding activity. One reason for the reluctance of shipowners to place orders for new vessels is that they are waiting until there is some definite indication of whether the internal combustion engine will replace the steam engine on ships engaged in services similar to their own. On steamships, great economies are being effected, and excellent results have been obtained on the Président-Dal-Piaz of the Compagnie Générale Transatlantique with superheated steam, whereby the economy of consumption is greater than can be secured with the type of Diesel engines constructed in France. Some orders for big motor ships have been given out, but as the construction of Diesel engines of high powers has been making slow progress in this country, the steam engine is probably holding its own more tenaciously than elsewhere.

Water Supply.

At Tours a supplementary water supply is to be obtained from the Ile Aucard in the Loire, where eight wells have been sunk to collect the water which filters through the thick sandy bed of the river. On account of the fineness of the sand special arrangements have had to be made to keep the wells free. They supply more than 500 litres per second. Orders are now being given for the construction of reinforced concrete galleries for the mains to the pumping station, which will contain six sets of electric motor-driven centrifugal pumps. At Lyons, also, the shortage of water is so serious that various methods are being investigated for ensuring an adequate quantity at all seasons, one proposal being for the sinking of wells and another for dredging a canal along the bottom of the river so that, whatever may be the level, there will always be a sufficient supply to the filtering beds. In some cases, notably at Nevers, serious difficulty has been experienced through pumps being choked with the fine sand when raising water from the wells near the river Loire.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

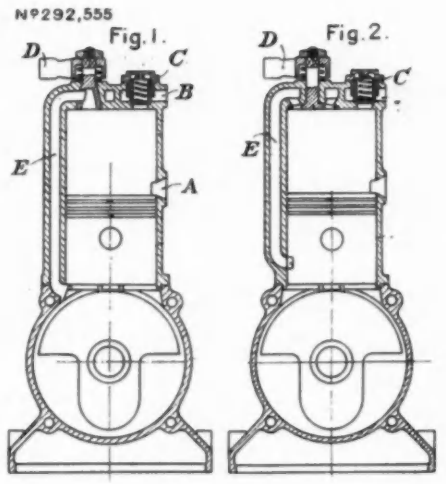
Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

292,555. June 19th, 1928.—COMPRESSORS FOR STARTING INTERNAL COMBUSTION ENGINES, Adalberto Garelli, of 13, Via Zenale, Milan, Italy.

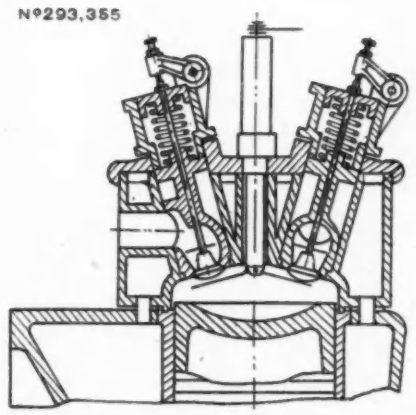
This invention relates to means for stopping the production of compressed air in motor-driven air compressors which may be used for starting internal combustion engines. In Fig. 1 a section through such a compressor is shown. At the lower position of the piston the suction port A is clear of the piston. The compressed air is delivered through the port B, which is controlled by an antumatic valve C. On the head of the cylinder there is mounted a conical-seated cock D, which may be closed or opened from outside the compressor, putting the cylinder space, when in the open position, into communication with the



passage E, communicating with the crank case. The volume of the passage and the cock may be so proportioned that when the cock is opened, the pressures on the upper and lower surfaces of the compressor piston are equalised, thereby enabling the motor or engine driving the compressor to be utilised for other purposes, such as dynamo driving, although the compressor is constantly kept in rotation. In Fig. 2 an alternative design is shown in which the passage E terminates in the wall of the cylinder and is closed by the piston before the suction port is opened. This arrangement may be utilised with advantage where the engine and compressor cylinders are built in V form with a common crank case. As shown in the illustrations either a conical or flat-seated valve furnished with ports is provided for.—*May 23rd*, 1929.

293,355. July 3rd, 1928.—CYLINDER HEADS, A. Franchetti, 2, Via della Fondina, Florence, Italy.

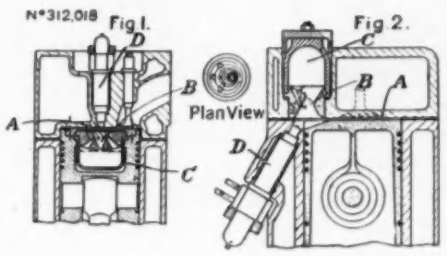
It appears that the inventor aims at convenience in cleaning the water spaces round the combustion chamber or cylinder head. He claims for "an internal combustion engine having a water-jacketed cylinder head divided, at right angles to the



cylinder axis, into two parts—an upper and a lower part—the upper part forming a cover for the lower part, wherein the valves are arranged in inclined positions to extend through both of said parts along ducts cast integral with said lower part and arms pivotally mounted on said upper part are provided for actuating said valves." The general form of construction is shown in the drawing.—*May 23rd*, 1929.

312,018. October 4th, 1928.—FUEL INJECTION AND IGNITION IN INTERNAL COMBUSTION ENGINES, Acro A.G., of Küssnacht am Rigi, Switzerland.

This invention relates to internal combustion engines of the pre-combustion chamber type, in which the self-ignition of the fuel is effected by injecting it into a compression chamber formed of three sections. These are the compressor space in the main cylinder A, a mixing chamber in free communication with this space B, and a chamber C connected with the mixing chamber solely by a throttling orifice. Whereas in known engines of this type this orifice consists of a single narrow port, the present invention provides for a plurality of ports, so that auxiliary jets of air meet the jet of fuel at a different angle to that at which the main current emerging from the throttling aperture meets it. Such action, it is claimed, promotes an intimate and rapid admixture of the air and fuel, thereby giving smokeless combustion. In Fig. 1 the chambers are shown arranged on the head of the piston, with the fuel valve D and the exhaust valve

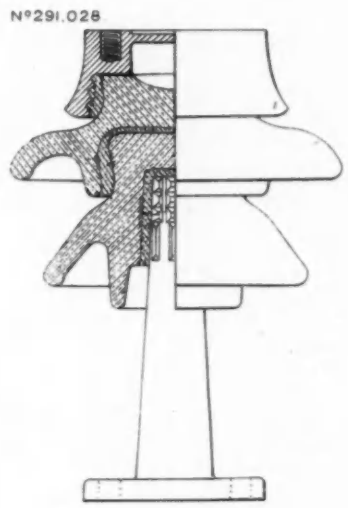


situated above the piston in the usual manner. In Fig. 2 the fuel valve D is fitted into the cylinder jacket casing and the mixing and auxiliary combustion chambers are arranged in the head of the cylinder.—*May 23rd*, 1929.

TRANSMISSION OF POWER.

291,028. May 19th, 1928.—MULTI-PART INSULATORS, D. H. Rowland, 915, Cathedral-street, Baltimore Maryland.

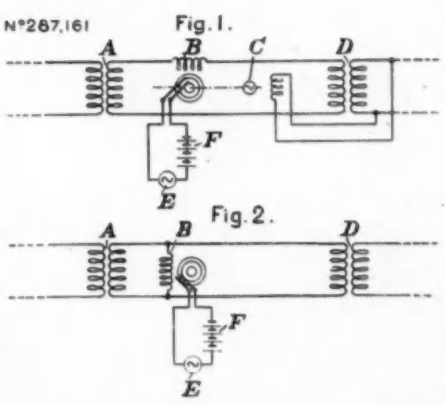
This invention relates to insulators, embodying a plurality of shells secured in assembled relation. The principal object of the invention, generally stated, is to provide a multi-part insulator, in which the successive porcelain shells are of such construction



and so secured as to avoid the provision of any sanded or otherwise roughened surfaces as a grip for the cement employed for securing purposes, the particular configuration of the parts being such that the cement will form a lock holding the parts against relative displacement. The design is so obvious in the drawing that no further description is necessary.—*May 23rd*, 1929.

287,161. February 25th, 1928.—REMOTE CONTROL ARRANGEMENTS FOR DISTRIBUTION SYSTEMS, C. Lorenz Aktiengesellschaft, 1, Lorenzweg, Berlin-Tempelhof, Germany.

The object of this invention is to superpose medium-frequency currents on heavy alternating-current lines by impressing the medium-frequency currents on the exciting winding of a synchronous machine, which machine may consist of a supply generator installed in the generating station. In Fig. 1 A is a transformer, which is connected to a long-distance 100,000-volt incoming line. In the circuit of the secondary winding of the high-voltage transformer, which may carry 6000 volts, there is arranged a synchronously driven booster B, the rotor



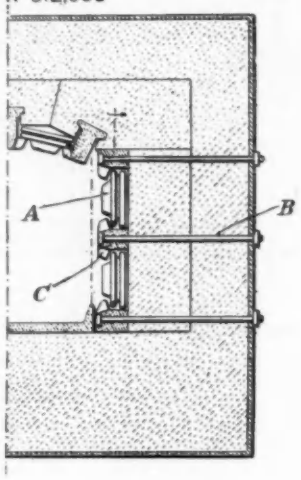
of which is driven by the synchronous motor C, whose winding is connected to the system,—in this particular case the secondary winding of a further low-voltage transformer F. The rotor winding of the booster B is supplied by a battery or machine E, in series with a medium frequency generator E. As soon as the rotor rotates synchronously with the frequency of the system, there are no frequencies arising from the heavy current lines on the rotor, and the medium-frequency current flowing in the winding is transferred to the winding of the booster B by pure transformer action. In Fig. 2 a circuit arrangement is shown in which a synchronous motor, preferably running idle and traversed by medium-frequency current in the same way as shown in Fig. 1, is connected to the system.—*May 23rd*, 1929.

FURNACES.

312,006. August 23rd, 1928. — ELECTRIC RESISTANCE FURNACES, Hevi Duty Electric Company, 217, Michigan-street, Milwaukee, Wisconsin.

In this electric furnace the heating elements are exposed, so that they radiate directly into the heating chamber. They are

N°312,006

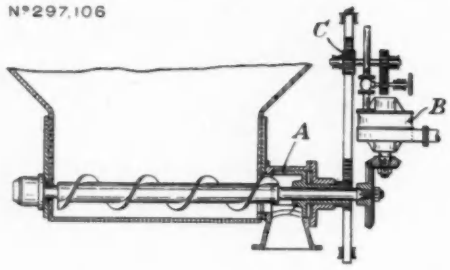


mounted on corrugated reflectors A, of ceramic material, and are held in place by bolts B, which terminate in fluted heads C, also of ceramic. Claims are made for considerable economies in time and energy consumption, as compared with other forms of construction.—*May 23rd*, 1929.

297,106. August 17th, 1928.—COAL DUST FURNACES FOR LOCOMOTIVES, G. Hayn, 1, Aschrott-strasse, Kassel, Germany.

The inventor suggests that there is a possibility in installations in which powdered coal is fed into a furnace by means of a screw conveyor of the fuel dribbling into the furnace when the

N°297,106



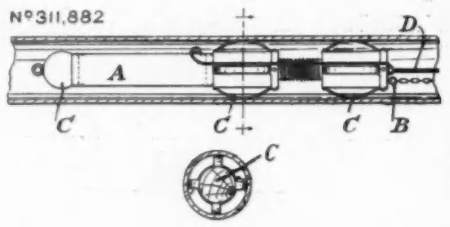
conveyor is intentionally stopped. So he introduces a rotary valve A in the outlet from the hopper and interconnects this valve with that supplying steam to the turbine B driving the conveyor in such a manner that both valves are opened or closed together. The drawing shows the interconnection in the form of rack and pinion gearing C.—*May 23rd*, 1929.

PUMPING AND BLOWING MACHINERY.

311,882. March 29th, 1928.—RECOATING THE INTERIOR OF WATER MAINS (IN SITU) AFTER CLEANING, F. W. Hammond, Gwenhalden, St. Lawrence-road, Chepstow, Mon.

The inventor proposes to protect the interior of water mains, which have been scraped to remove incrustations by means, of

N°311,882



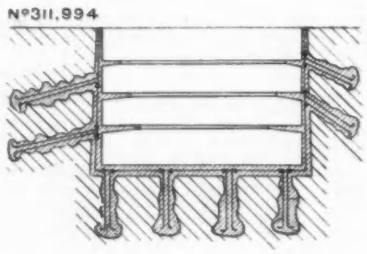
an electrolytically deposited layer of metal. The pipe is filled with electrolyte and the copper electrode A is drawn through by means of the chain B. C C C are wooden insulators to prevent the electrode from touching the side of the pipe and D is the electric supply cable. An electromotive force of about 100 volts is suggested.—*May 23rd*, 1929.

BUILDING.

311,994. July 30th, 1928.—THE CONSTRUCTION OF DOCKS, J. F. Barr, Killineer House, Drogheda, County Louth, Irish Free State, and A. Wolfsholz, 2b, Via Aguggiari, Varese, Italy.

In the usual construction of docks, locks and like structures, these structures have a weight greater than the weight of water which enters the structure. The present invention has for its

N°311,994



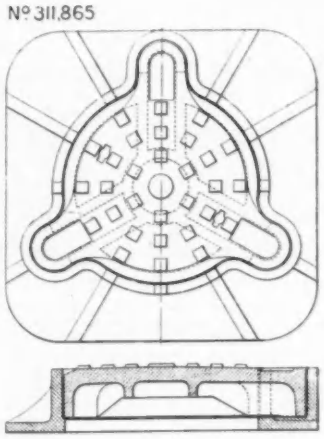
object the reduction of the weight and mass of such structurse. According to this invention the floor as well as the side walls are directly connected with anchors which penetrate deeply into the adjacent soil. In this manner the weight of the subsoil immediately adjacent to the structure is employed to counteract the lift due to the water and to render impossible floating, or a fracture, of the structure.—*May 23rd*, 1929.

MISCELLANEOUS.

311,865. March 13th, 1928.—MANHOLE COVERS, S. F. Seaward, 36, Richmond-road, Wimbledon, S.W. 20, and S. S. Rogers, Grosvenor House, Somerset-road, Brentford.

The inventors state that when manholes are so placed that they

N° 311,865



are subject to passing traffic, the cover tends to rock on account of the difficulty of casting it with a truly plane under-surface or seating. They consequently adopt what might be described as a three-point support, which is plainly indicated in the drawing. —*May 23rd*, 1929.

LAUNCHES AND TRIAL TRIPS.

DEEBANK, cargo vessel; built by Workman Clark (1928), Ltd., to the order of Messrs. Andrew Weir and Co., for their Bank Line services; dimensions, 420ft. by 56ft. 6in. by 36ft. 3in.. Engines, quadruple-expansion, 22in., 32in., 46½in. and 68in. by 48in. stroke, pressure 260 lb. per square inch; constructed by the builders; trial trip, June 11th.

NIMANOA, auxiliary ketch; built by Philip and Son, Ltd., Dartmouth, to the order of the Crown Agents for the Colonies; semi-Diesel auxiliary motor; launch, June 11th.

MARTINETTA, twin-screw motor yacht; built by J. I. Thornycroft and Co., Ltd., to the order of Mr. A. G. Lomax, of London; dimensions, 91ft. 8in. by 17ft. 6in. by 7ft. 6in. Engines, two sets Gardner cold-starting heavy-oil engines; launch, June 12th.

BARON RAMSAY, steel screw cargo steamer; built by D. and W. Henderson and Co., Ltd., to the order of H. Hogarth and Sons, Ltd.; dimensions, 350ft. by 50ft. by 25ft. 9in.; to carry cargo. Engines, triple-expansion; 21¼in., 37in., 62in. by 42in. stroke; pressure, 210 lb. per square inch; constructed by the builders; launch, June 13th.

BRITANNIA, steamship; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of Rederiaktiebolaget Svenska Lloyd, of Gothenburg; dimensions, 376ft. by 50ft.; to carry 2230 tons. Engines, Parsons turbines; a speed of 19 knots was attained on trial trip, June 17th.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INSTITUTION OF MECHANICAL ENGINEERS.—Manchester. Summer meeting. **For programme see page 302, March 15th, 1929.**

PHYSICAL SOCIETY.—At the Imperial College of Science, Imperial Institute-road, South Kensington, S.W. 7. A demonstration of some Contact Devices used in an Apparatus for the Measurement of Electrical Resistance at High Temperatures, by Dr. J. L. Haughton; "The Relation between Hydrogen Pressure and Filament Resistance in a Tube containing Glowing Tungsten," by Dr. Teresa J. Dillon; "The Band Systems of Titanium Oxide," by Dr. Frances Lowater; "The Absolute Measurement of Sound Intensity," by Mr. F. D. Smith, M.Sc. 4.45 p.m. Editing Committee meeting, 3.30 p.m. Council meeting, 4 p.m.

MONDAY, JULY 1ST.

ROYAL INSTITUTION OF GREAT BRITAIN.—General meeting, 5 p.m.

TUESDAY, JULY 2ND.

INSTITUTION OF ELECTRICAL ENGINEERS: SOUTH MIDLAND CENTRE.—**Summer meeting. Visit to the Avonmouth Docks. Assemble main booking hall, G.W.R., Snow Hill, Birmingham, 11 a.m.**

TUESDAY TO THURSDAY, JULY 2ND TO 4TH.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—**Bolbec Hall, Newcastle-upon-Tyne. Summer meeting in Newcastle-upon-Tyne, jointly with the Institution of Engineers and Shipbuilders in Scotland. "The Story of Safety at Sea," by Sir Westcott S. Abell; "Developments in the Uses of Electricity," by Mr. R. P. Sloan; "The Applications of Monel Metal in Engineering and Shipbuilding," by Mr. John Ireland; "Some Notes on Damage to Ships," by Mr. J. L. Adam.**

TUESDAY TO FRIDAY, JULY 2ND TO 5TH.

BRITISH WATERWORKS ASSOCIATION.—Portsmouth. **For programme see page 447, April 19th, 1929.**

THURSDAY AND FRIDAY, JULY 4TH AND 5TH.

INDUSTRIAL WELFARE SOCIETY.—Eighth annual conference of Editors of Works Magazines at Norwich.

FRIDAY, JULY 5TH.

INSTITUTION OF CIVIL ENGINEERS.—Birmingham and District Association. **Visit to Liverpool to see the work in connection with the Mersey Tunnel. Leave New-street Station at 8.30 a.m.**

OVERHEAD LINES ASSOCIATION.—**Visit to the Mid-Cheshire Electricity Supply Company. The visit will start at 12.15 p.m. at Winsford (Gravel) Station (L.M. and S.).**

SATURDAY, JULY 6TH.

PHYSICAL SOCIETY.—**Visit to Birmingham. The following programme has been provisionally arranged:—Leave Paddington 9.10 a.m., arrive Leamington 10.44 a.m. On arrival at Leamington the party will drive by motor omnibus, provided by the University, to Birmingham *viâ* Warwick. At Warwick a stop will be made to enable members to inspect Warwick Castle and other places of historic interest. Lunch will be taken at the University Refectory in the Edgbaston Buildings about 1.30 p.m., and thereafter the meeting will be held and the University Science Buildings will be open to inspection.**

TUESDAY TO SATURDAY, JULY 9TH TO 13TH.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.—**Royal Show at Harrogate.**

WEDNESDAY TO FRIDAY, JULY 10TH TO 12TH.

ELECTRICAL ASSOCIATION FOR WOMEN.—**Fourth Annual Conference at the North-East Coast Exhibition, Newcastle-on-Tyne.**

INSTITUTION OF MINING ENGINEERS.—Eighty-ninth general meeting at Nottingham.

TUESDAY TO SATURDAY, JULY 16TH TO 27TH.

AIRCRAFT EXHIBITION.—Olympia. Seventh Internationa Aircraft Exhibition.

TUESDAY TO THURSDAY, JULY 23RD TO 25TH.

NEWCOMEN SOCIETY.—Summer meeting at Dartmouth, Devon. **For programme see page 434, April 19th, 1929.**

SATURDAY TO TUESDAY, AUGUST 3RD TO 13TH.

INSTITUTION OF ELECTRICAL ENGINEERS: LONDON STUDENTS' SECTION.—**Summer Tour, 1929. The Students' Section summer tour will be held this year in Paris and Northern France.**

END OF VOL. CXLVII.

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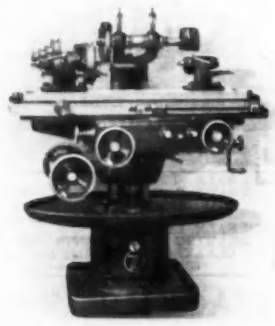

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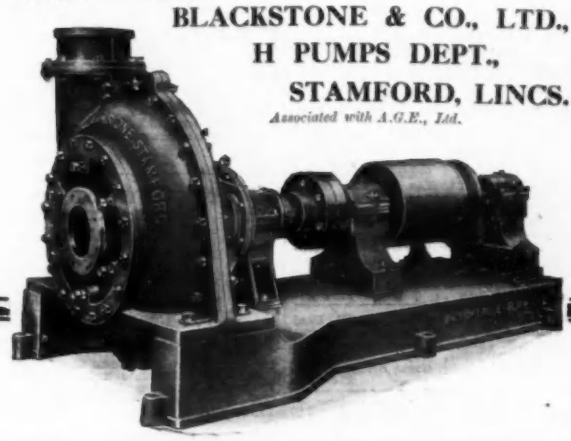

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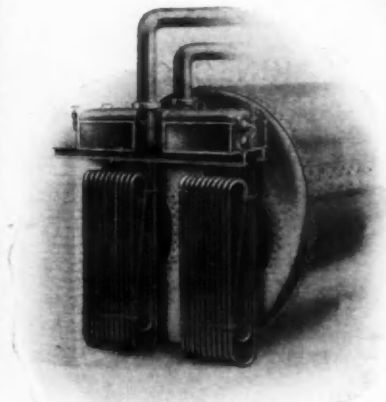

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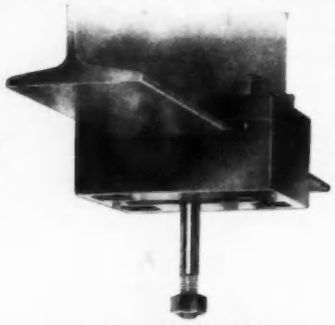

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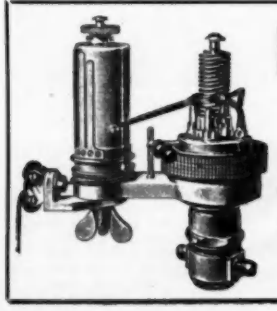

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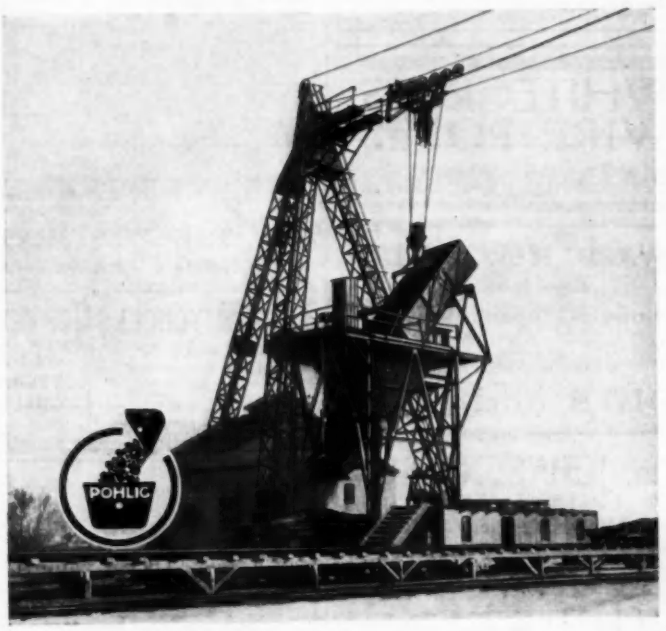

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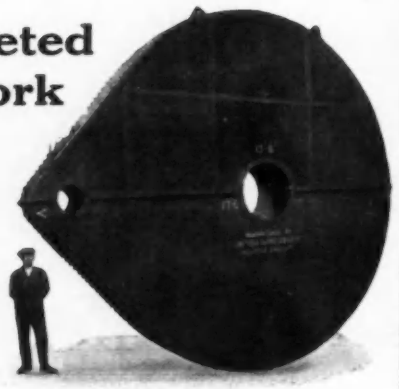
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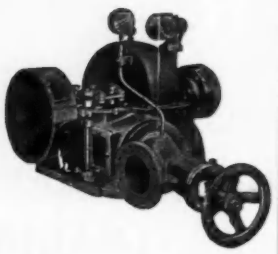
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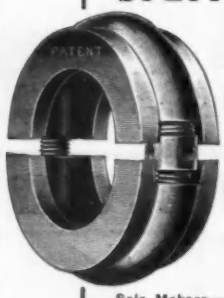
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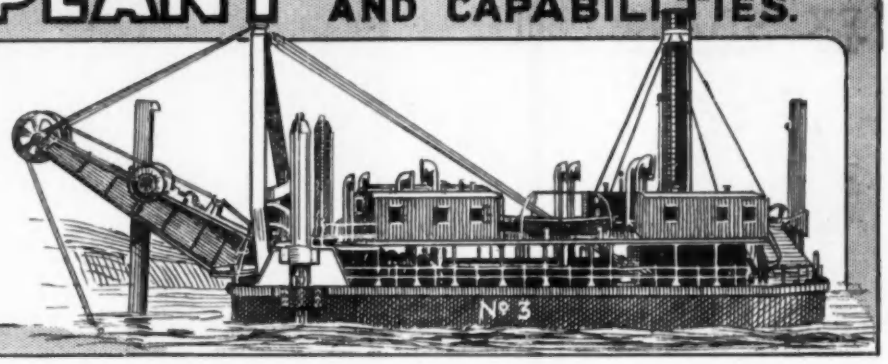

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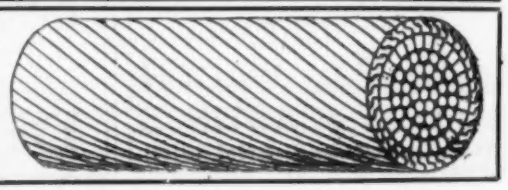

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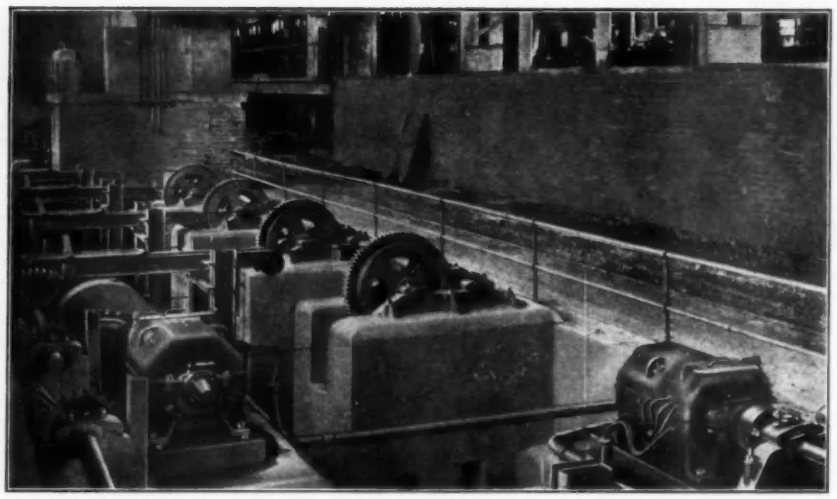

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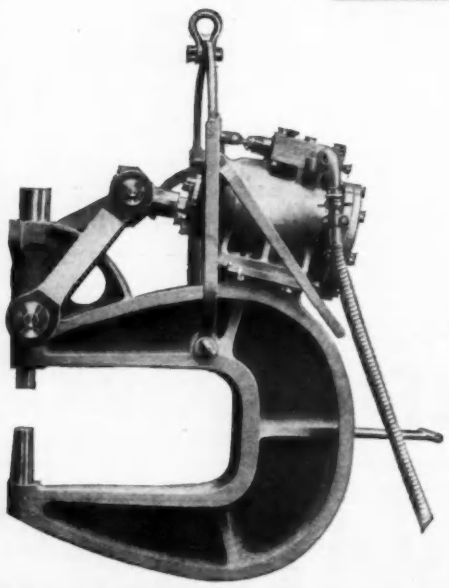

MANY rivets are so unfortunately placed that their inaccessibility for any but percussion hammer riveting precludes the possibility of anything better than a second-rate job.

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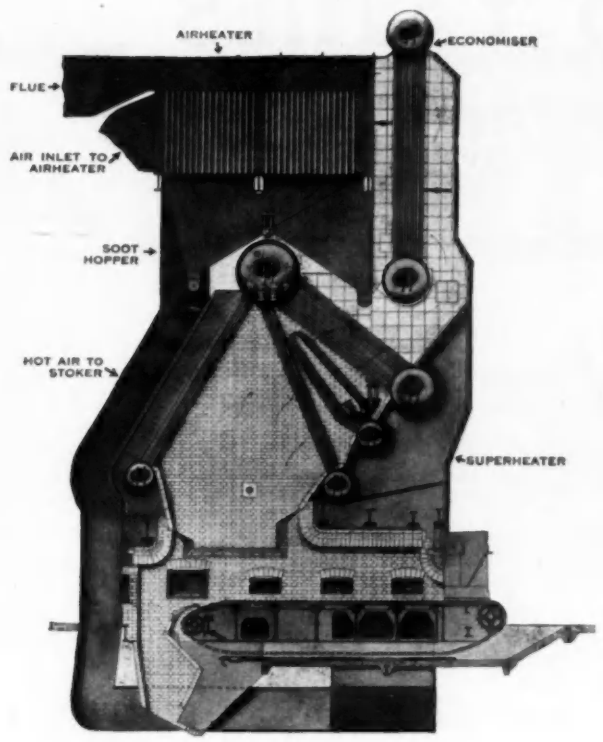

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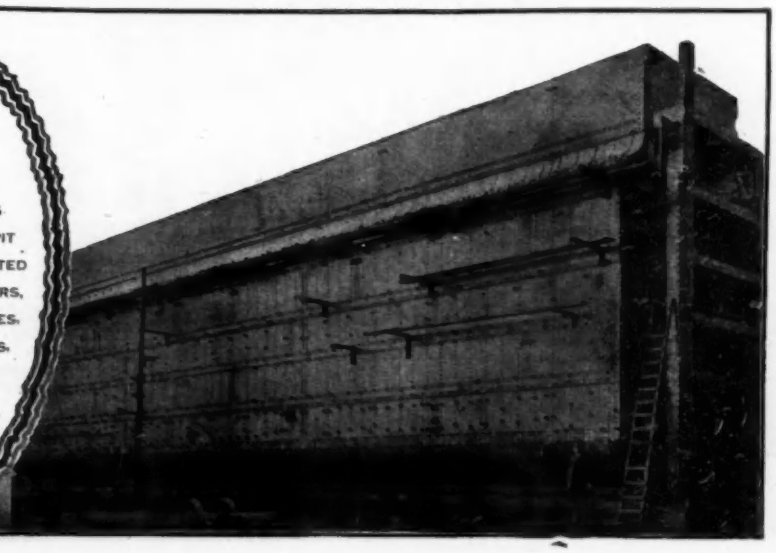

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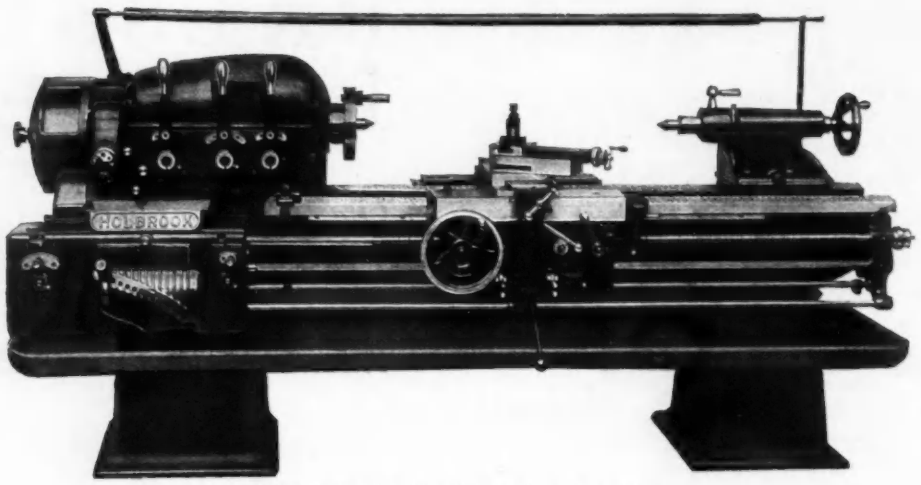

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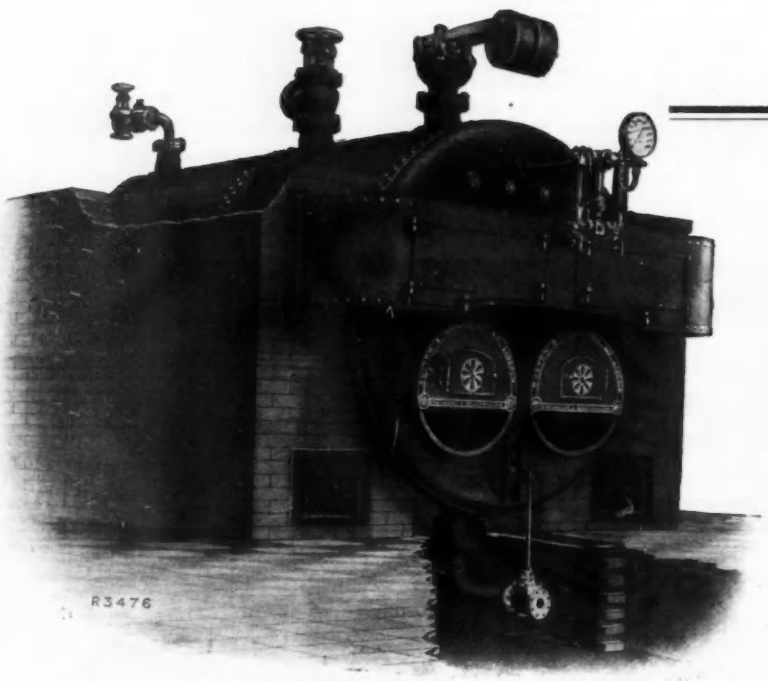

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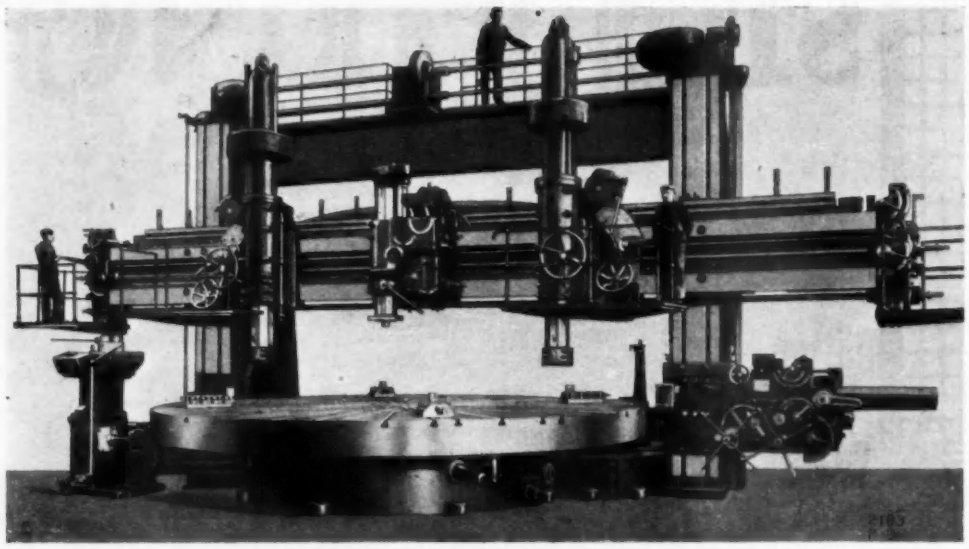

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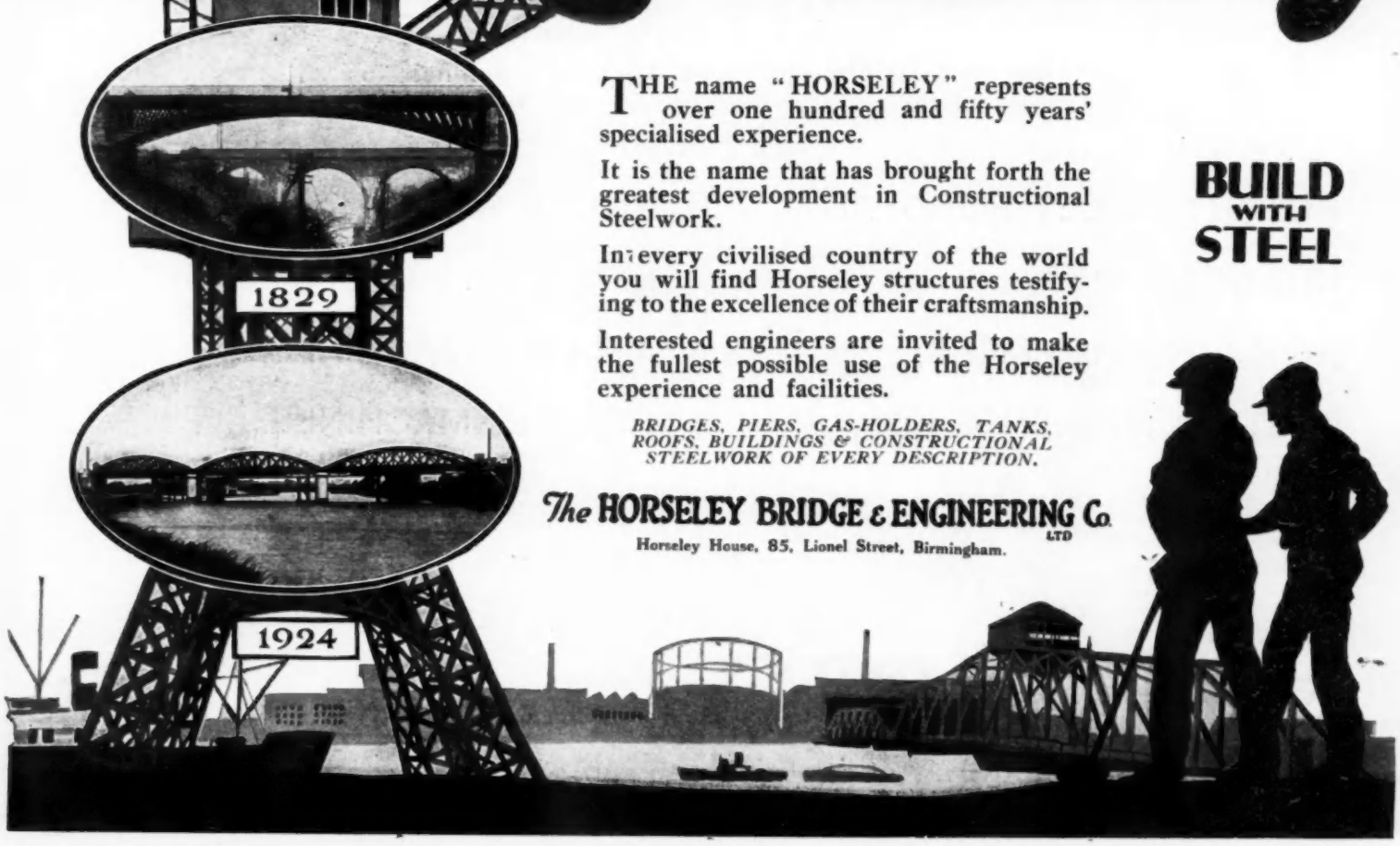

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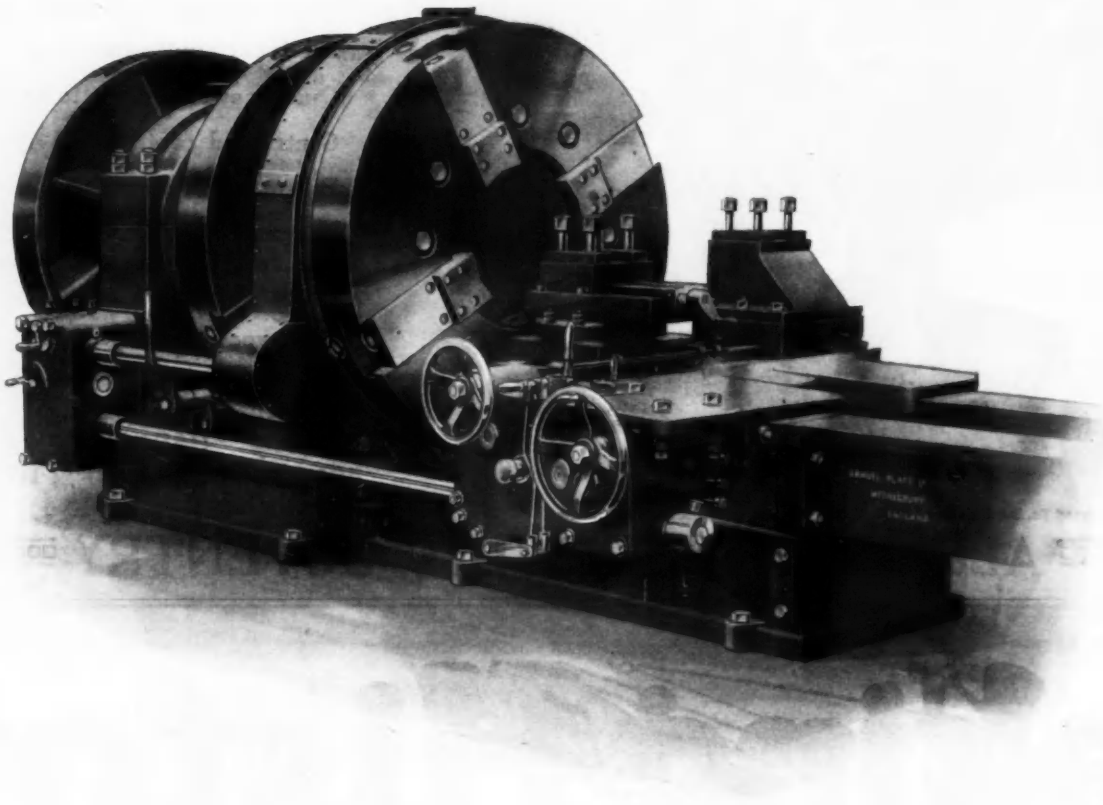

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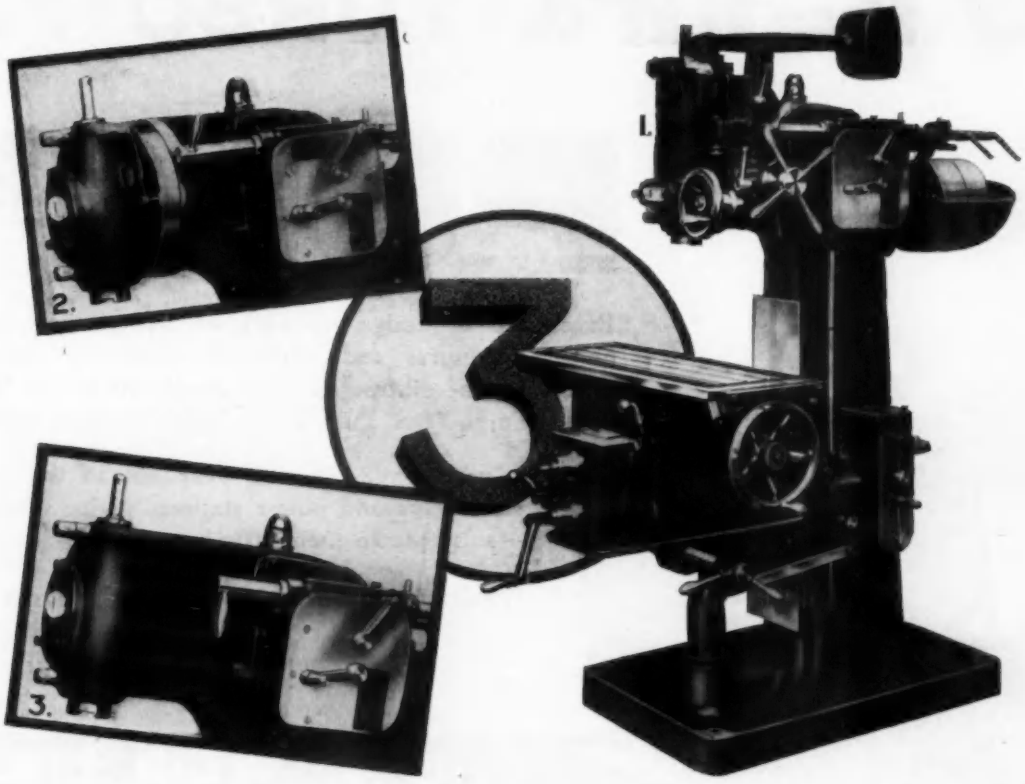

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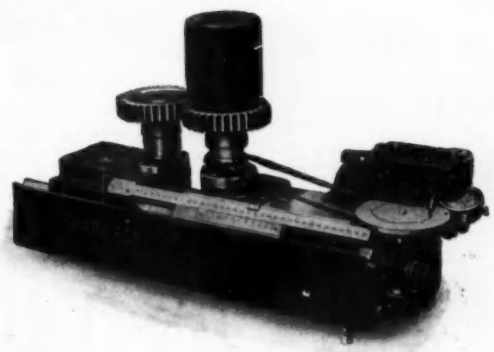

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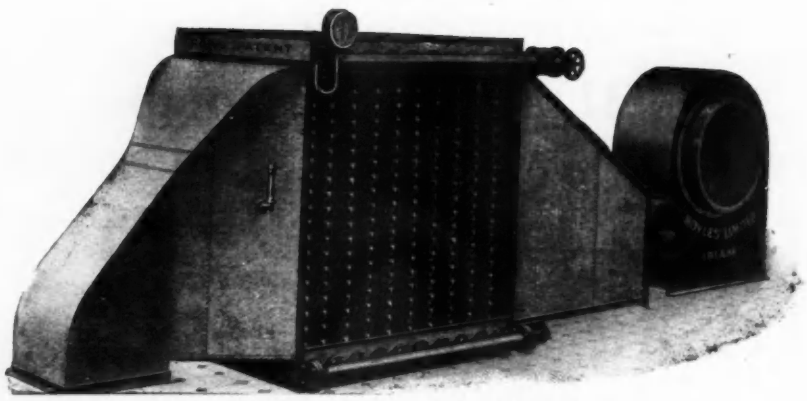

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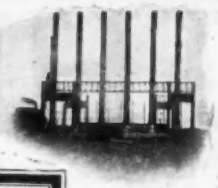

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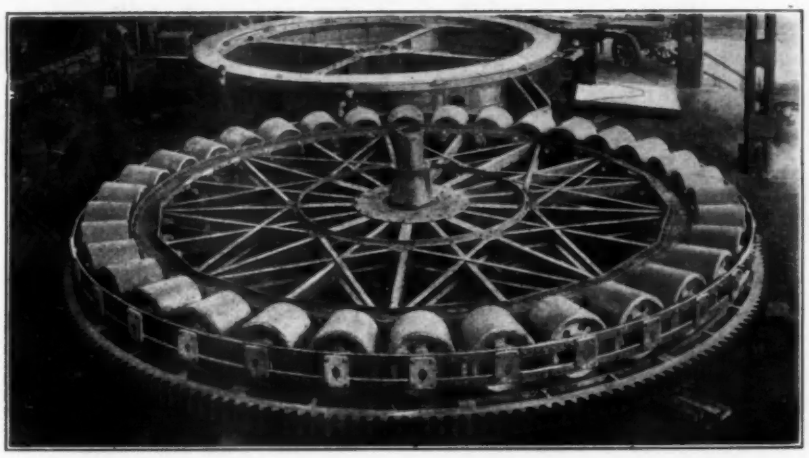

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HERE is a Portable Jib-crane of new and original design which provides a unique versatility of movement. It is a crane of such innate and all-embracing mobility that it can go where no other crane can go and do what no other crane can do. It is a crane—a New Morris Crane—which permits of such savings in time, effort and expense that it literally opens up a new era in the general handling of goods and materials.

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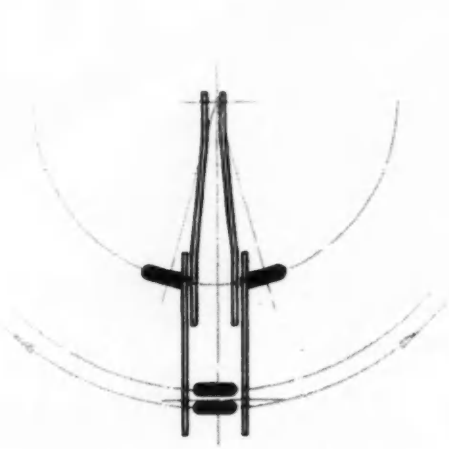
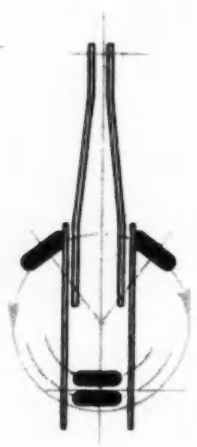
This versatile Morris Crane operates as an independent unit, and can pick up a load anywhere and take it anywhere else. As a petrol electric crane (or alternatively fitted with a battery of accumulators), it is not tied down to any fixed source of power.

Here is the Portable Crane the world has been looking for. In practically every job of handling it cuts out at least one movement, and in most jobs it cuts out three or four movements with the consequent saving of time.

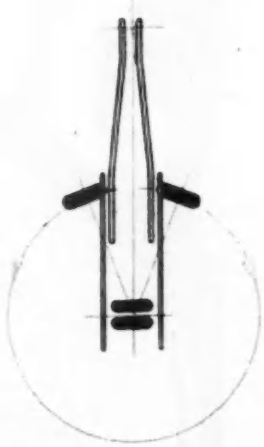
Folder E 211 gives further information of interest to every industrial manager. Shall we send you a copy?



Rotating round the load.



Rotating round its own axis.



Rotating round its rear wheel.

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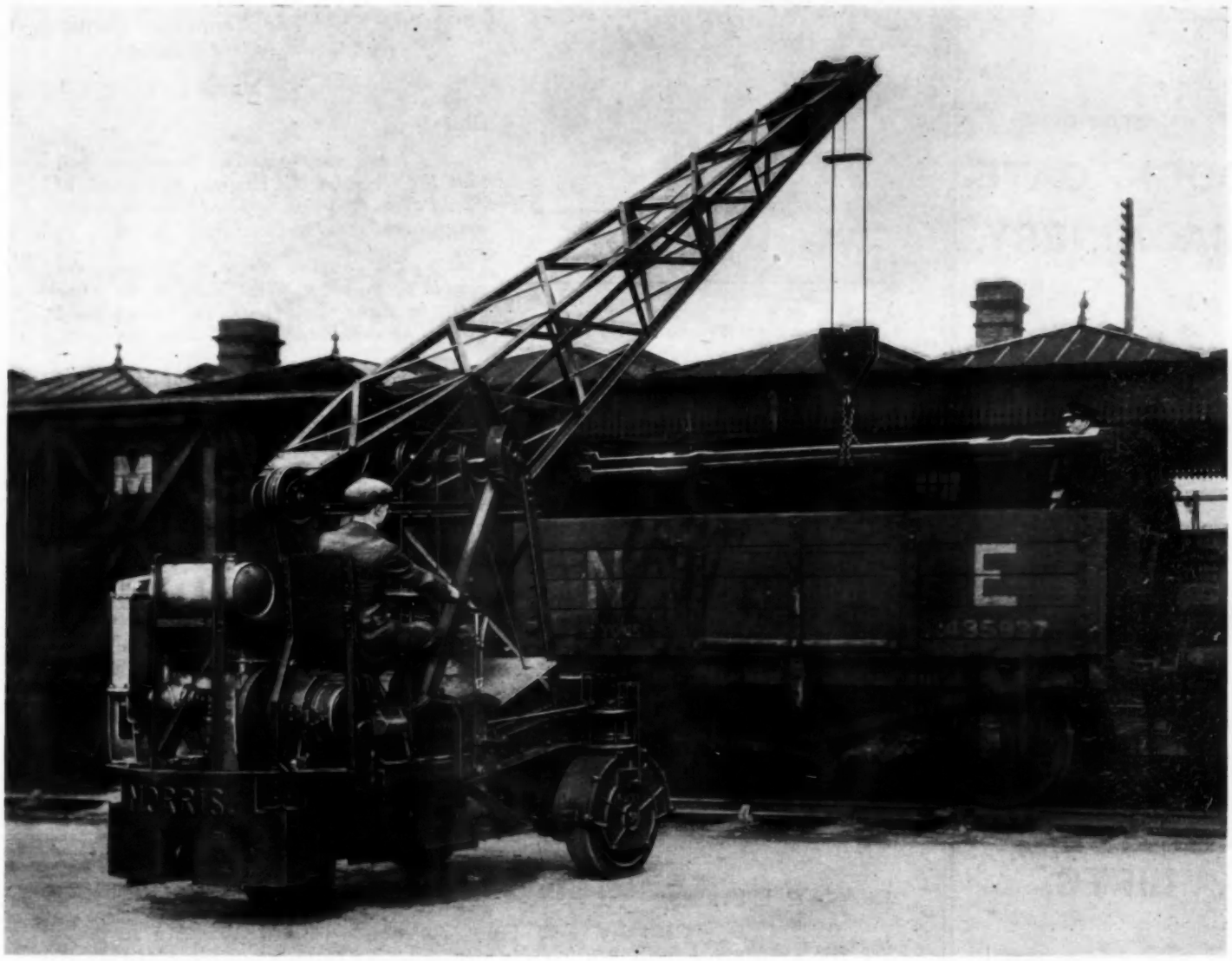
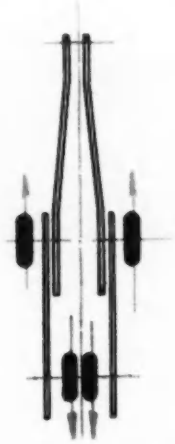
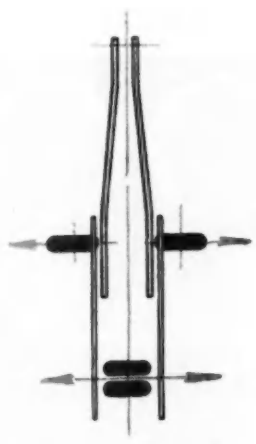




Travelling forward and backward.



Travelling sideways.

Study these diagrams. They illustrate valuable movements never before contemplated in crane design.

This shaking off the shackles of obsolete limitations as to freedom of travel has opened up a new vista for those who look for greater efficiency in material handling.

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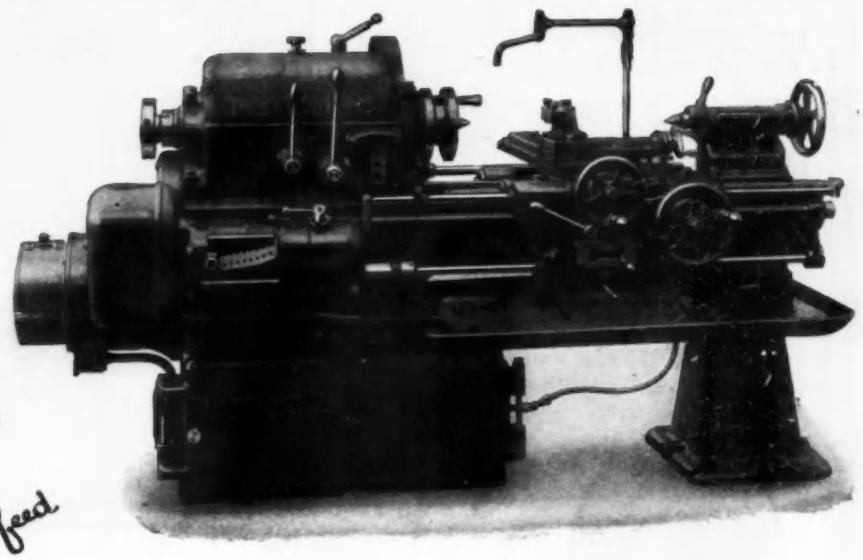

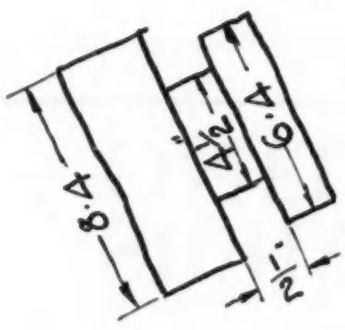

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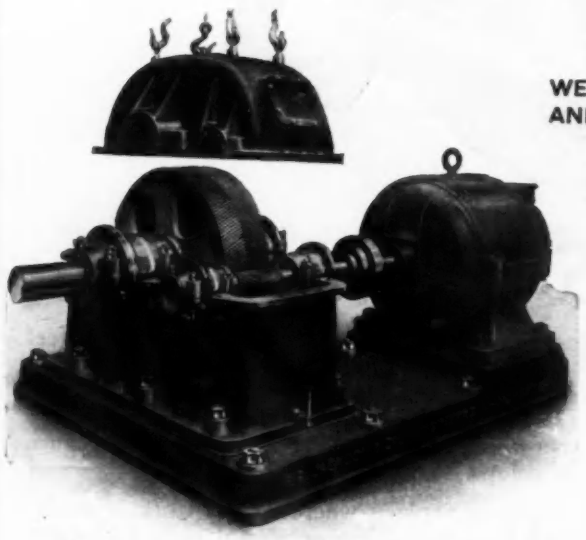

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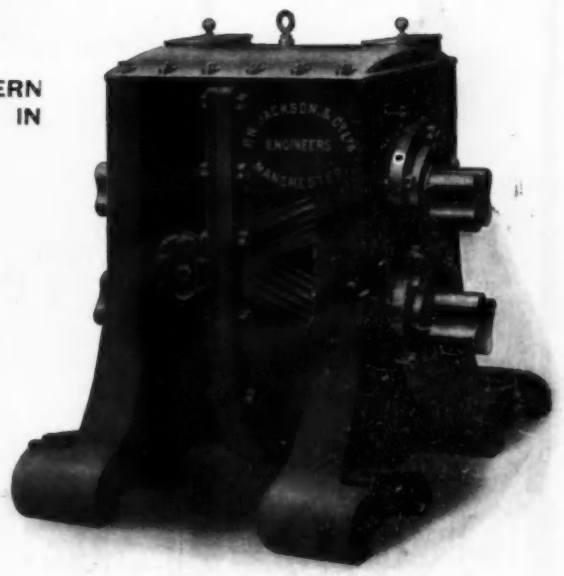

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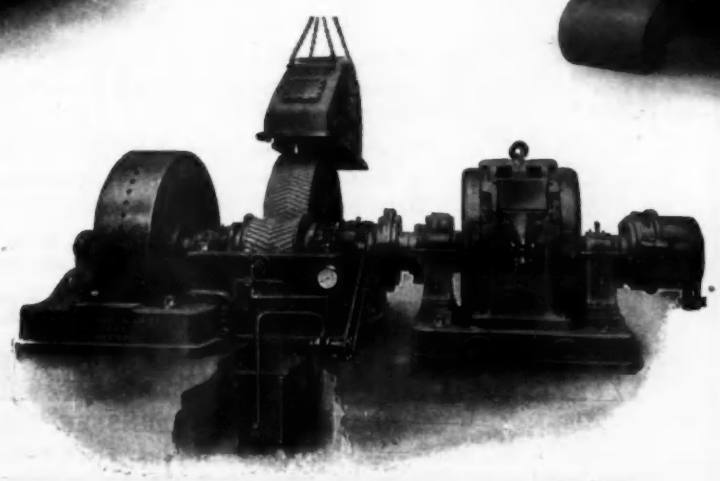

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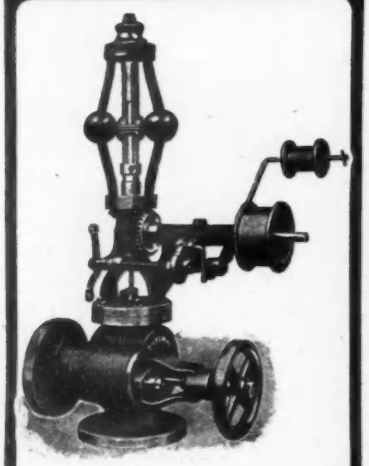

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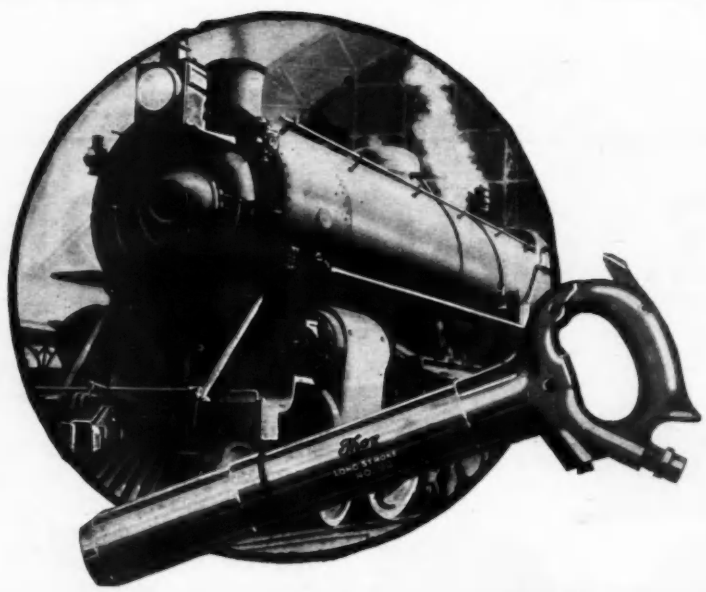

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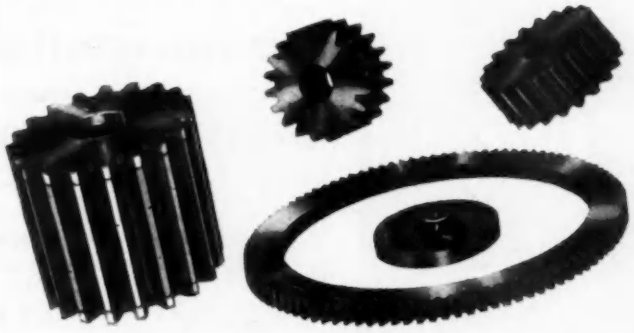

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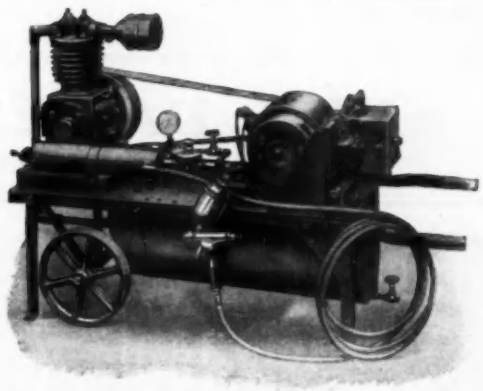

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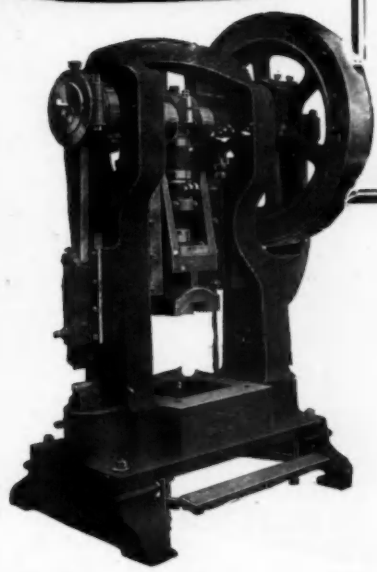

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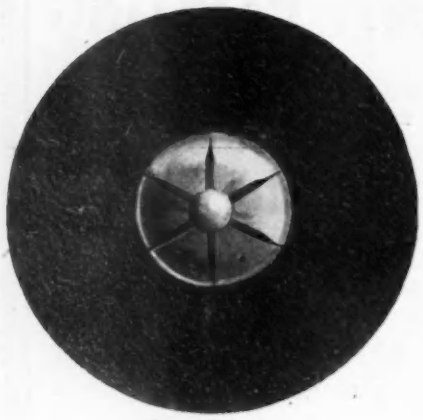

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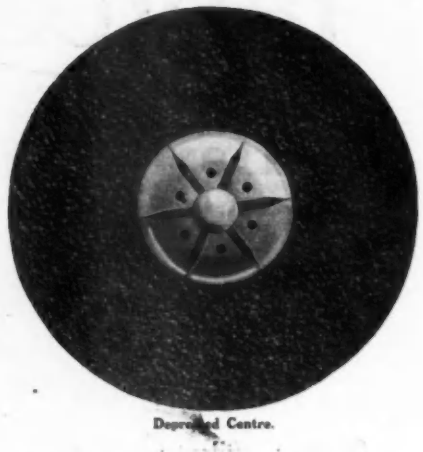

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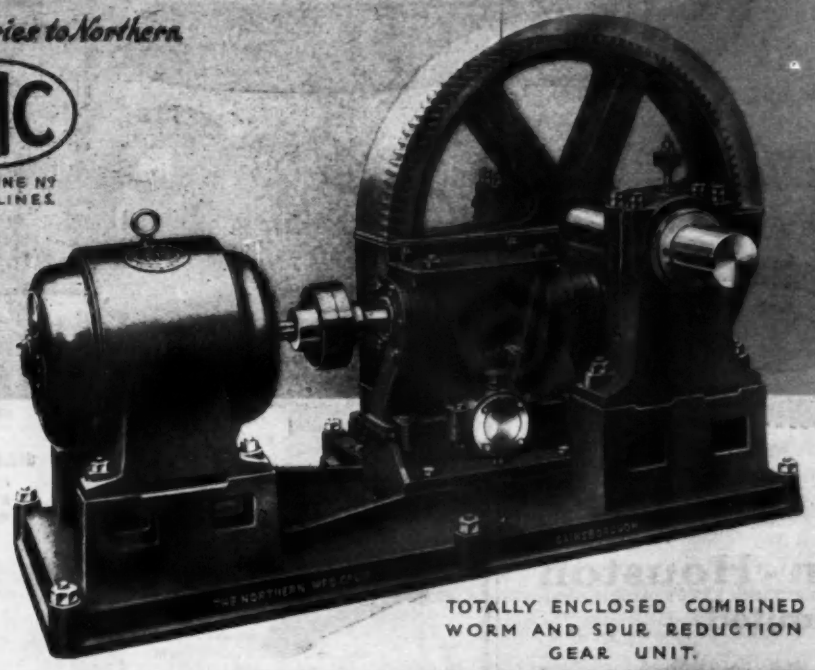

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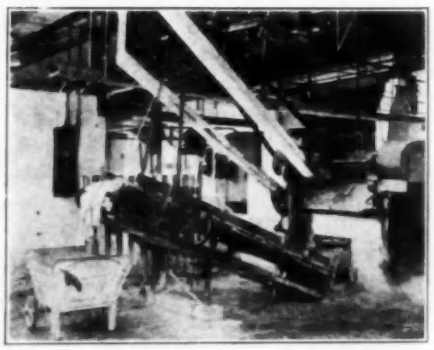

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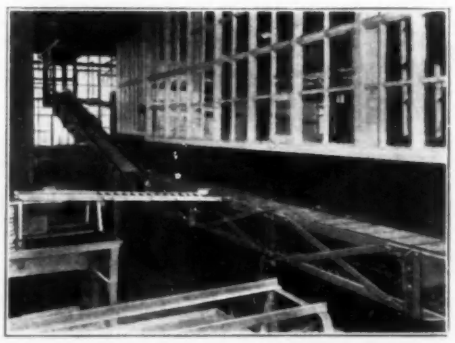
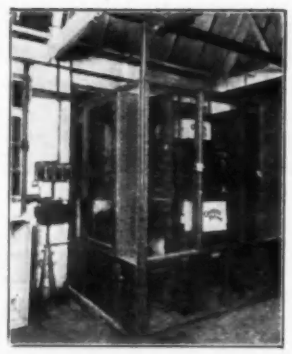
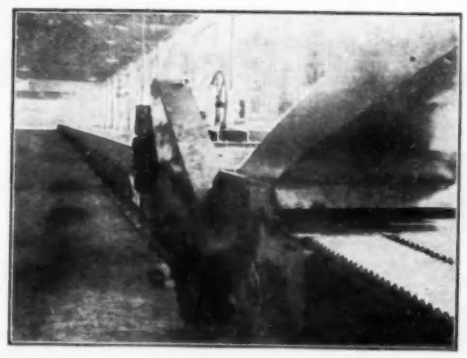


Horizontal and Inclined Slat Conveyor in a Magneto Assembly Works.



A SWING TRAY ELEVATOR for handling cartons or boxes, from ground floor to upper floor.



An Oven Conveyor. This machine is 200 feet long and carries 13½ tons.

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E. 140

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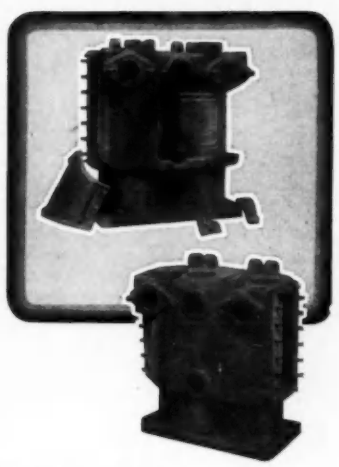
Every year large sums of money are lost by scrapping plant in which broken parts could be easily repaired and worn parts replaced by Oxygen Welding.

A Case in Point—

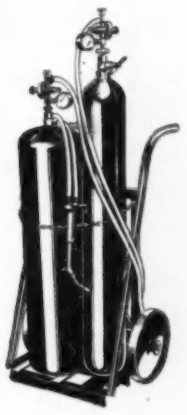
But for Welding, this broken machine frame would have been thrown on the scrap heap; it was repaired, and again put into service, thus saving the cost and waste of time incurred in obtaining a new part.



Another Instance—

This cracked engine cylinder was recently repaired by welding, and re-machined at a total cost of £4 5s. 0d.

The cost of replacing it with a new cylinder would have been about £12 12s. 0d.



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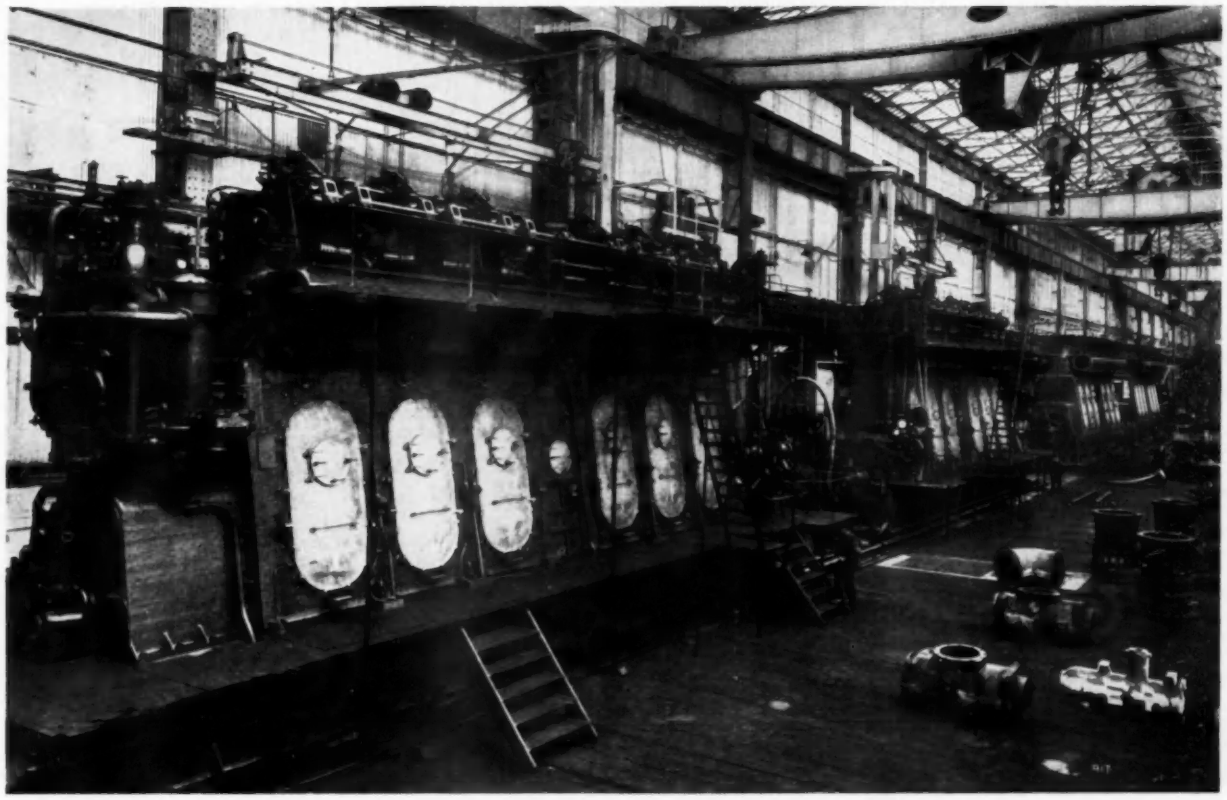

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A And
N N-sure
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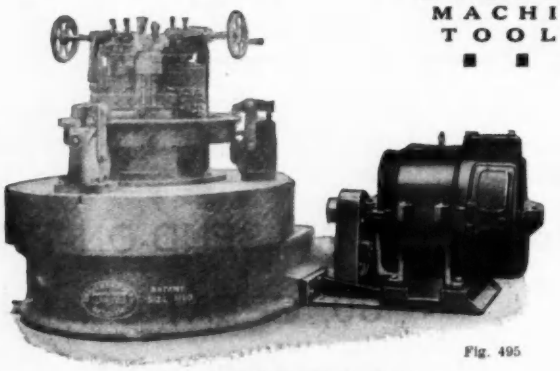

Fig. 495

"A" Type Motor Driving Boring Machine.

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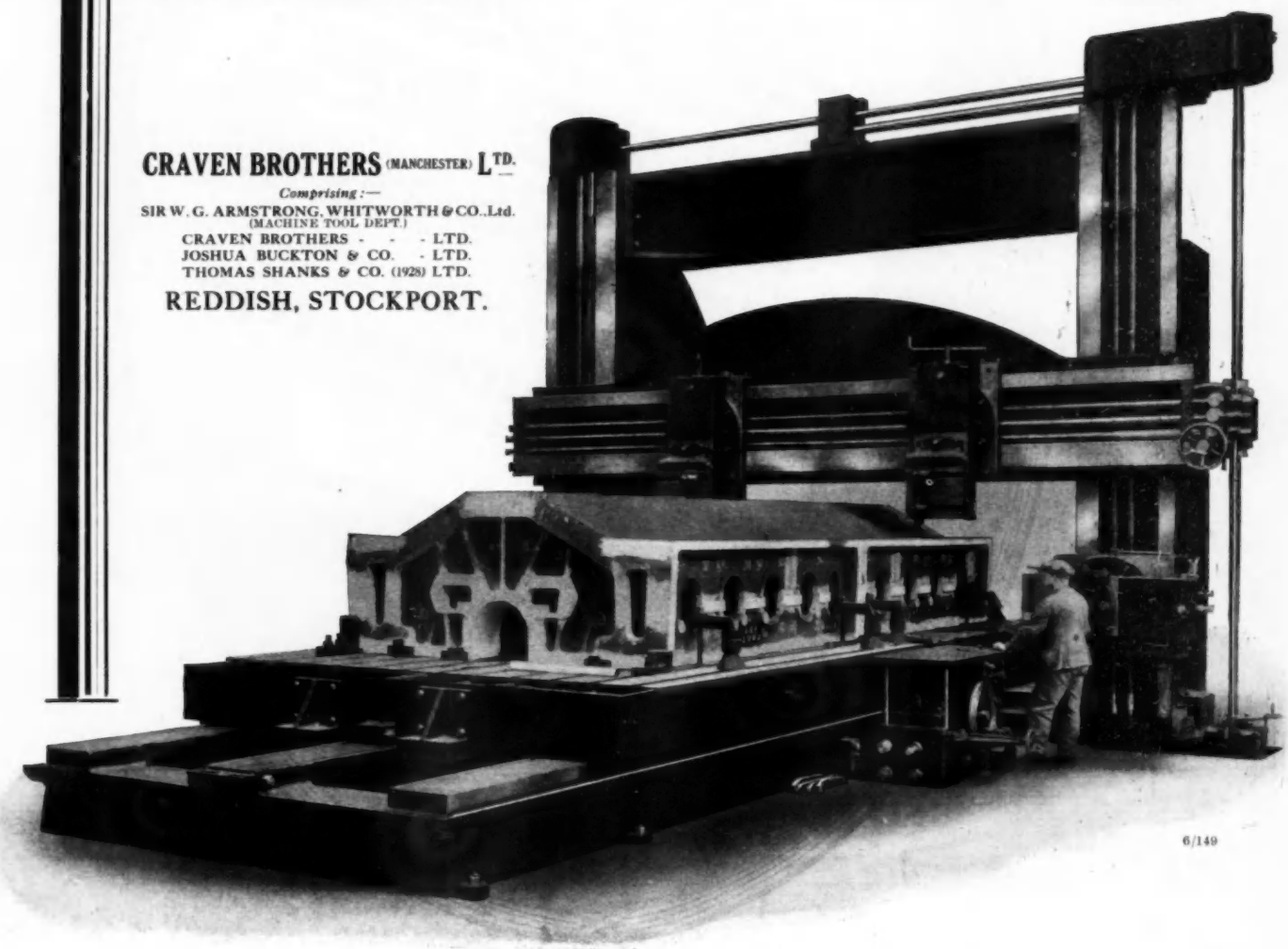

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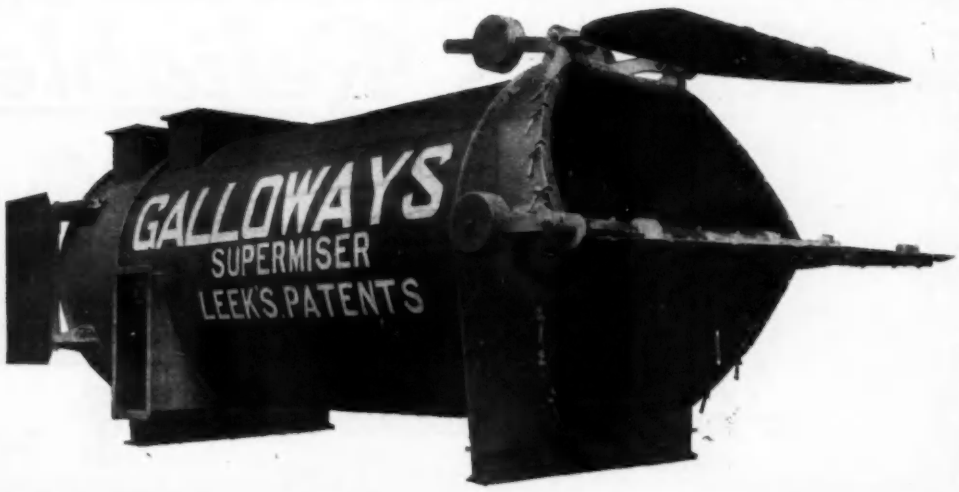

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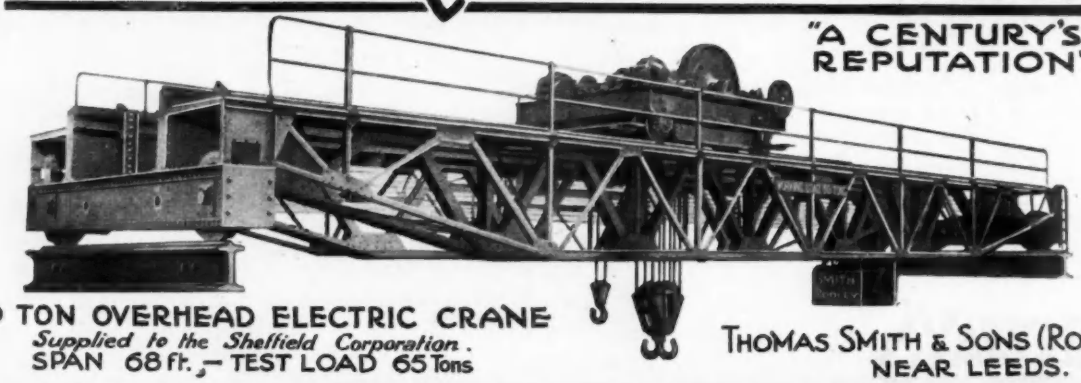

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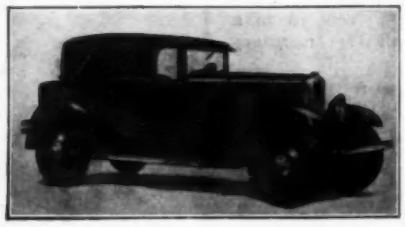
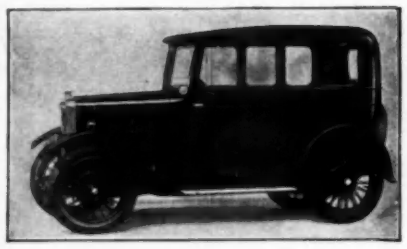
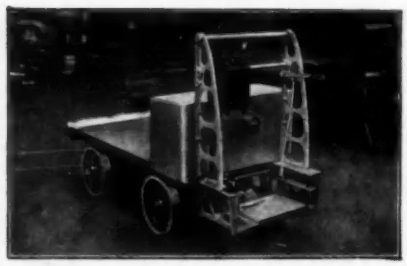
WORM GEAR



The 9 H.P. "Peugeot."

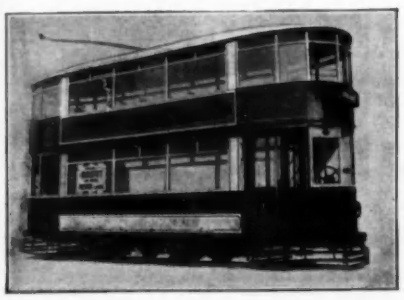


The "Triumph Super Seven."



Worm driven electric runabout.

"Aboag" bus with "Voran" front wheel drive.



The first worm driven tramcar (Hull Corporation).

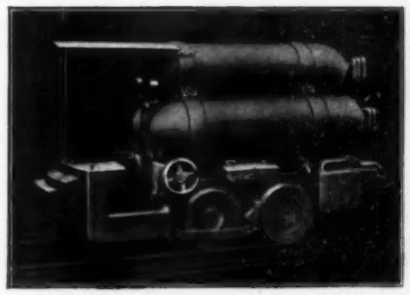
for every drive.

No other gear has so many features and such varied uses as the "DBS" patent worm drive.

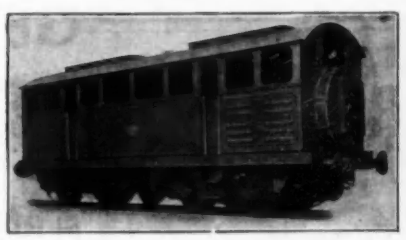
Its wide range of ratios—usable either for reducing or increasing speed—and high load carrying capacity make it easily adapted to almost any drive. It can be used with shafts at right angles or askew and gives a convenient multiple drive with easy mounting.

Once installed, its silent running, high efficiency and long life can be relied upon with confidence. "DBS" engineers, armed with long experience and wide knowledge of worm gear design and application, will gladly co-operate in planning new drives.

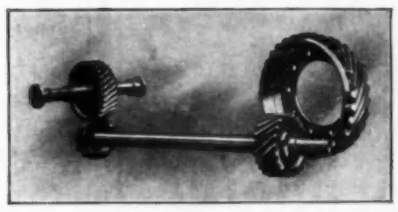
The Thornycroft "Hathi" four wheel drive tractor.



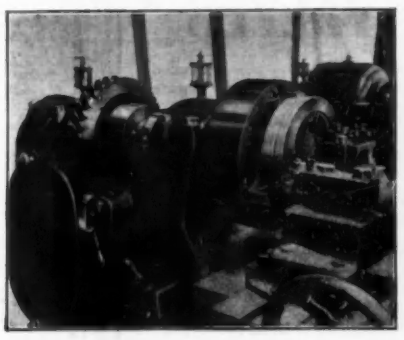
"Hohenzollern" compressed air worm driven locomotive.



Durtnall "Paragon" electric locomotive.



Gears for submarine Diesel engine.



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No foundations needed—

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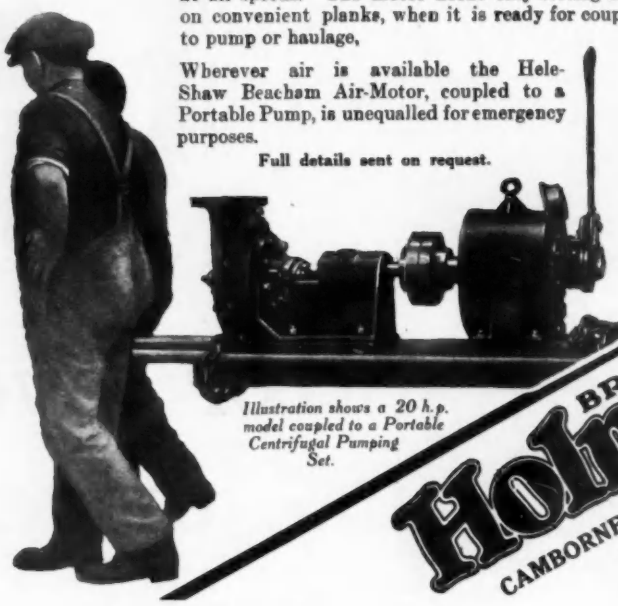

Illustration shows a 20 h.p. model coupled to a Portable Centrifugal Pumping Set.

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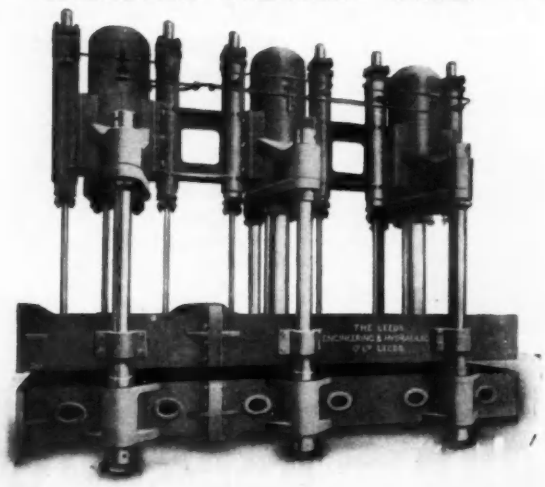

FIG. NO. 287—Total Power 400 tons, Table 18ft. 6ins. x 5ft. 0in.

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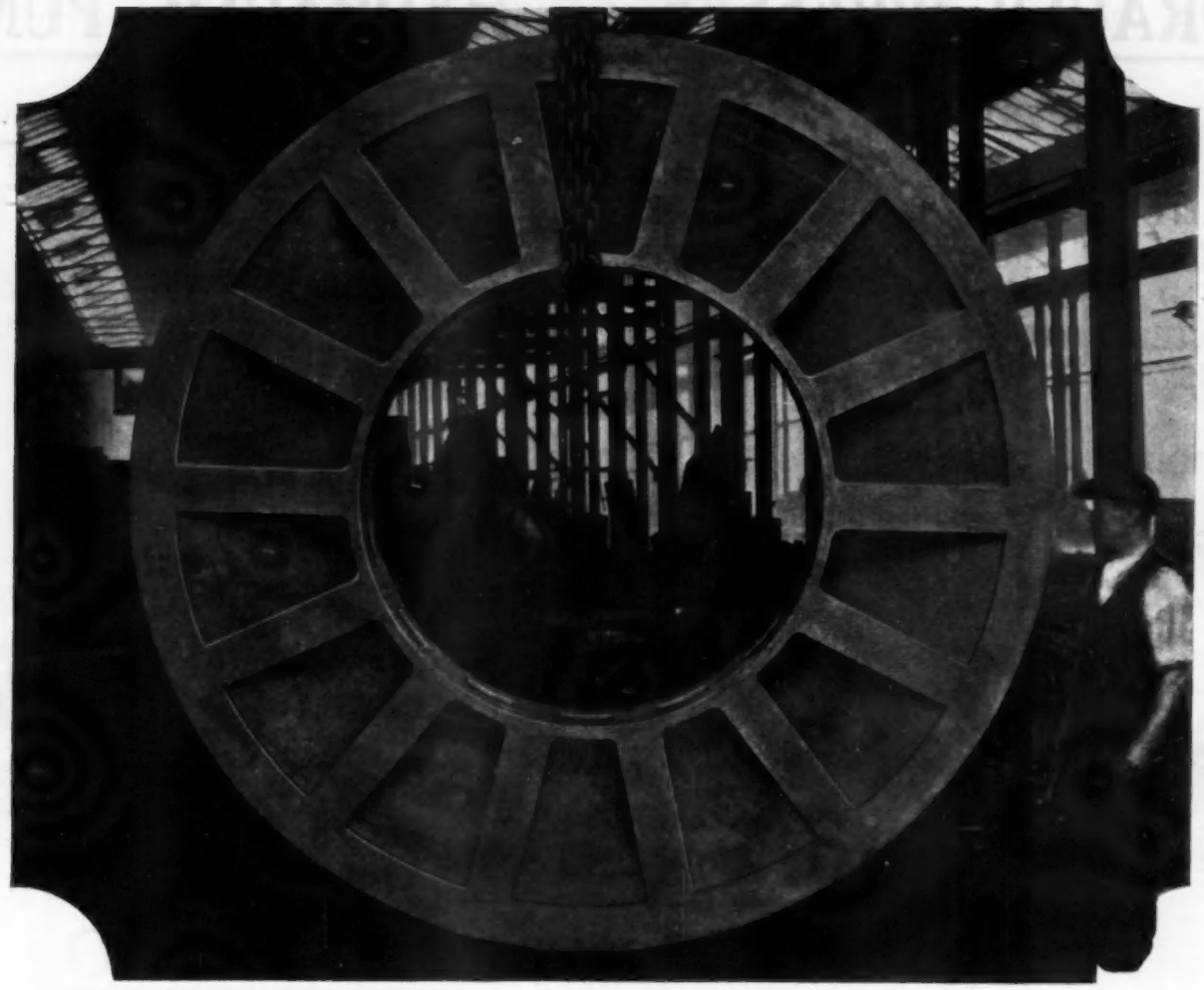

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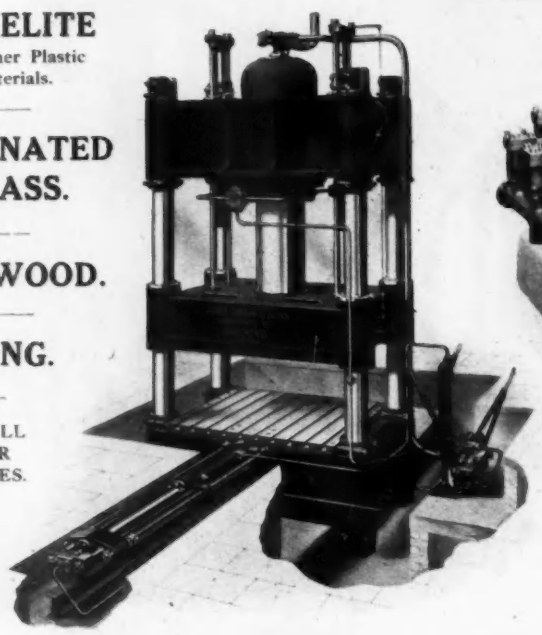

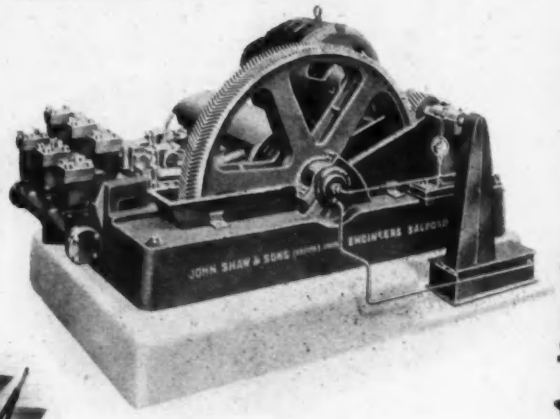

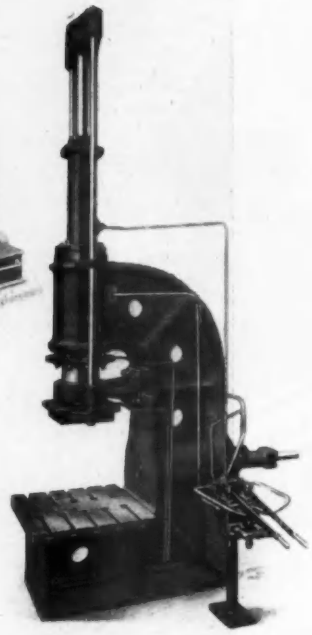

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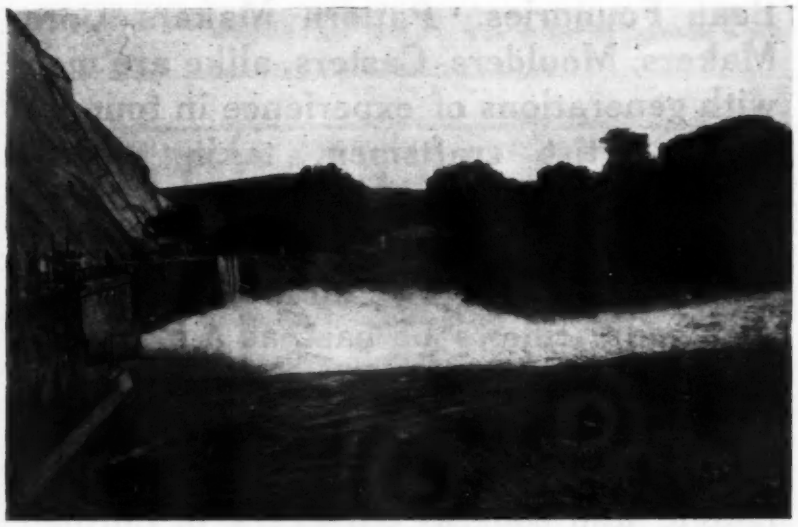

The illustration shows a Disperser, 42in. dia., fitted to a dam outlet and discharging under a head of 75 feet. Dispersers have been installed under heads up to 1,670 feet, and successfully dissipating energy amounting to over 10,000 shock H.P. in a single jet, allowing the water to be deposited into a shallow pond without causing more than a surface disturbance.

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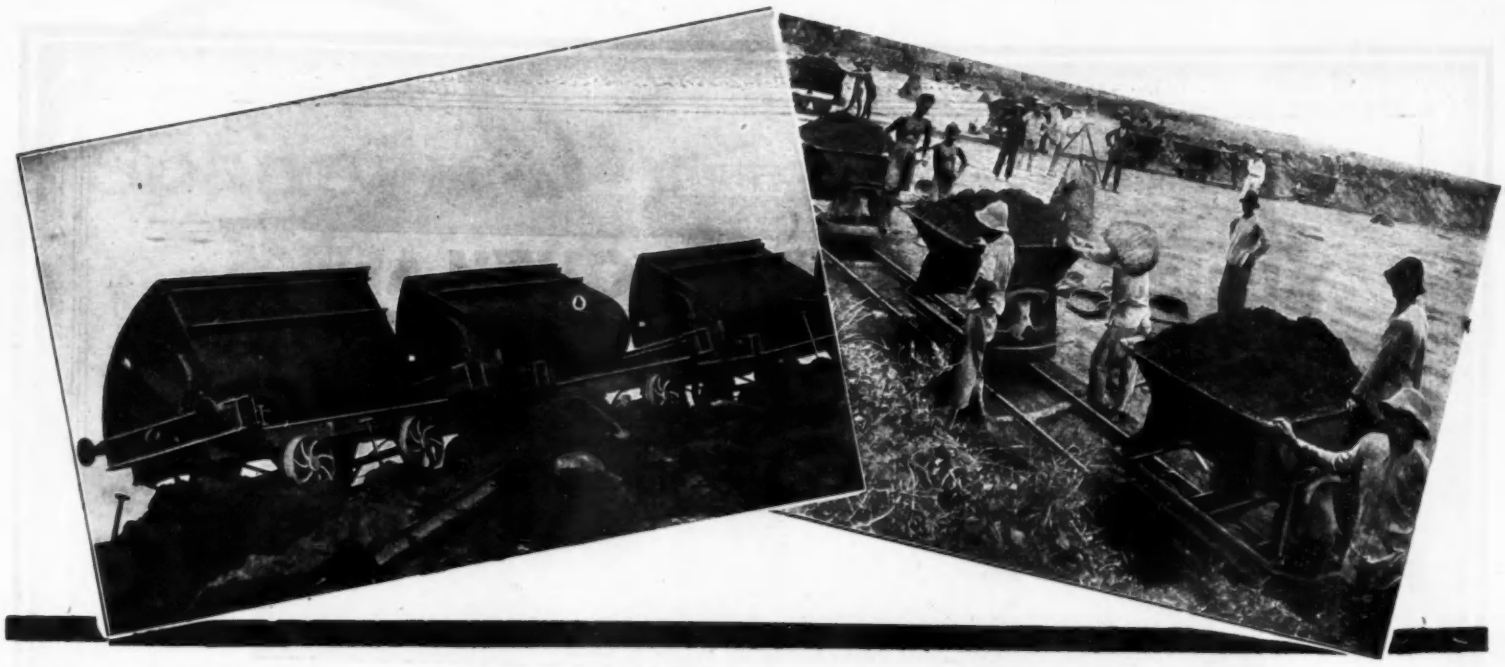

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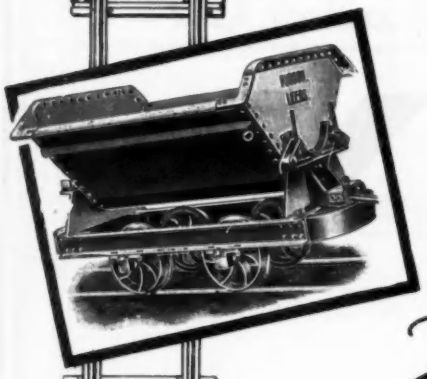

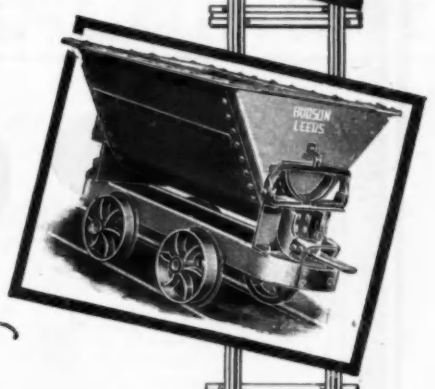

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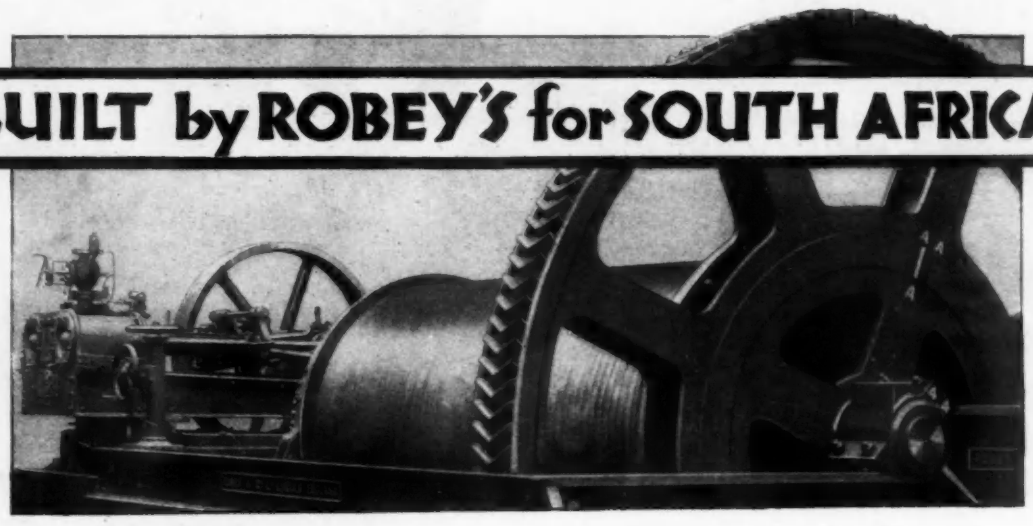

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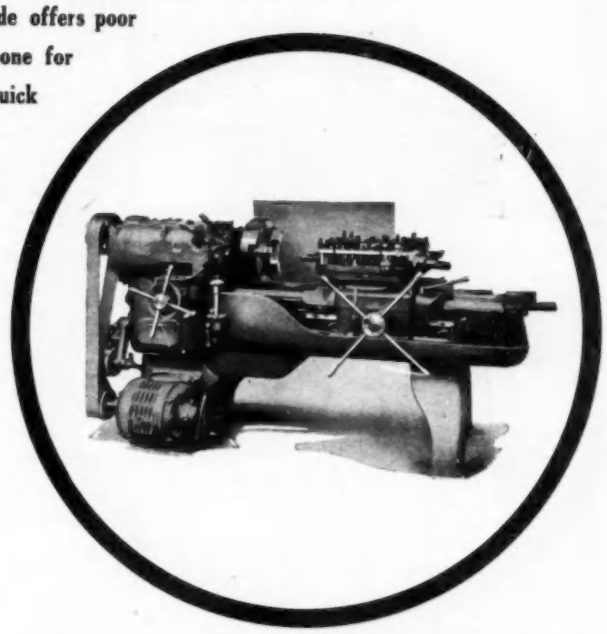

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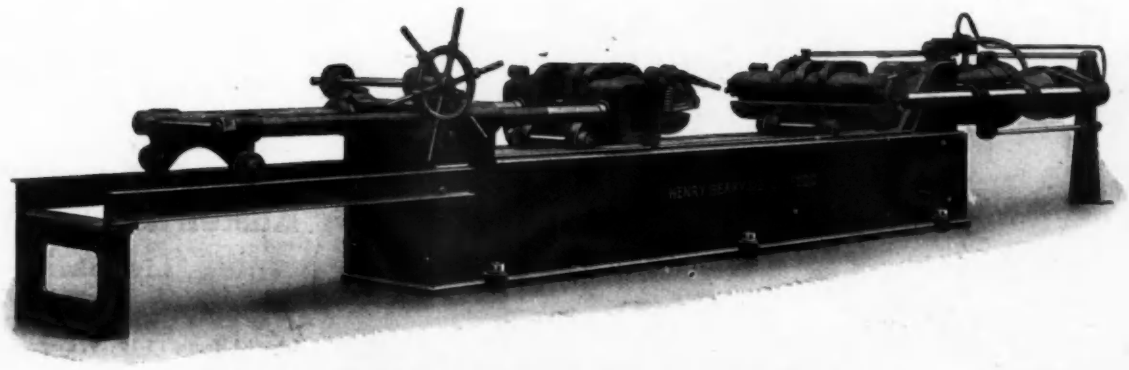

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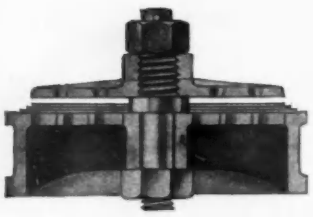

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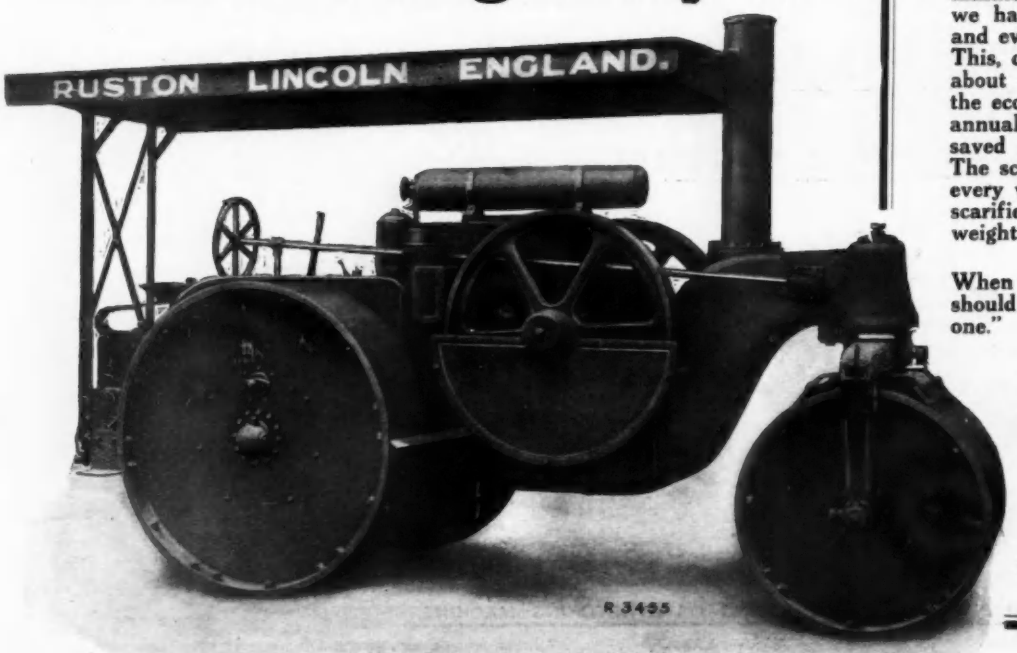

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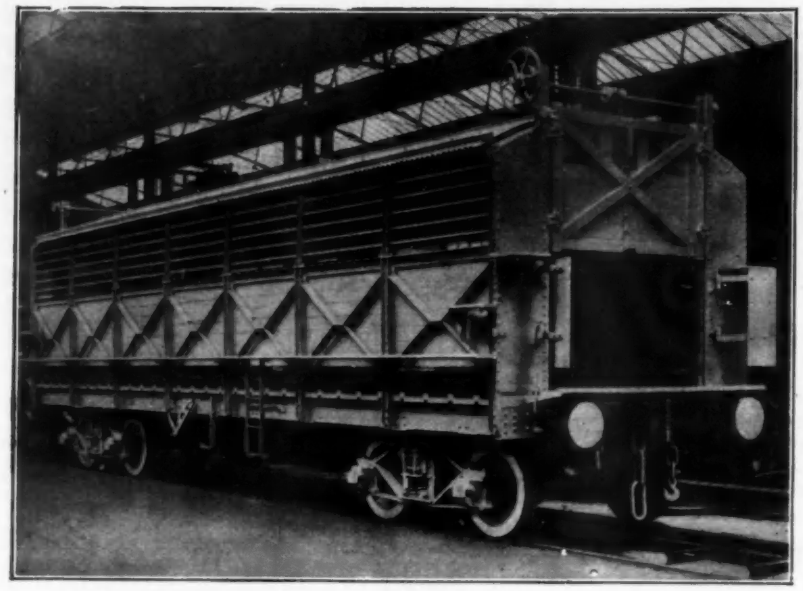

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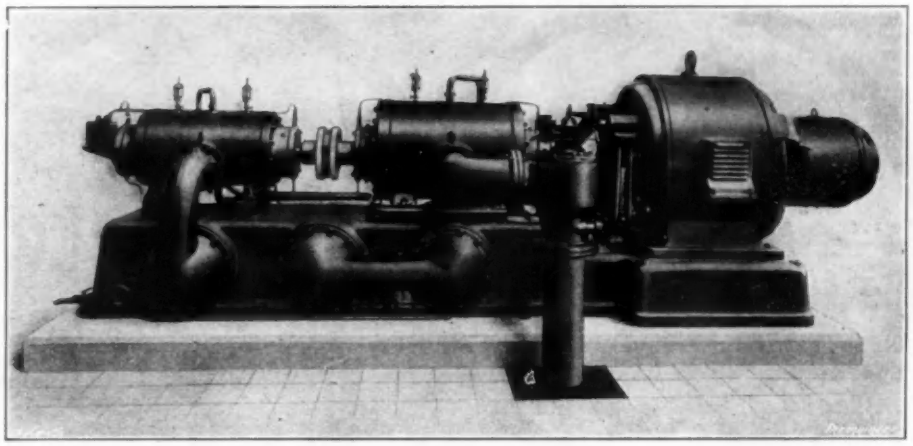

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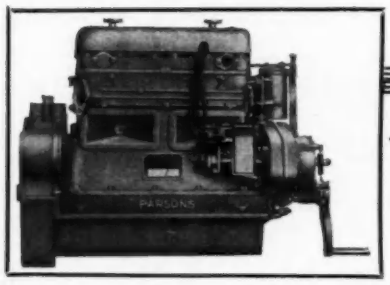

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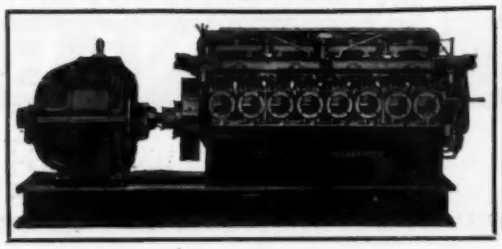

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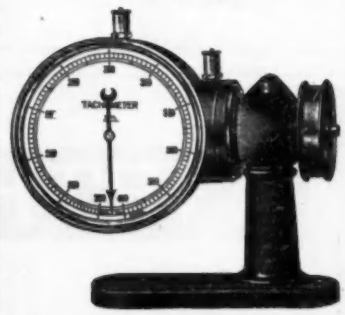

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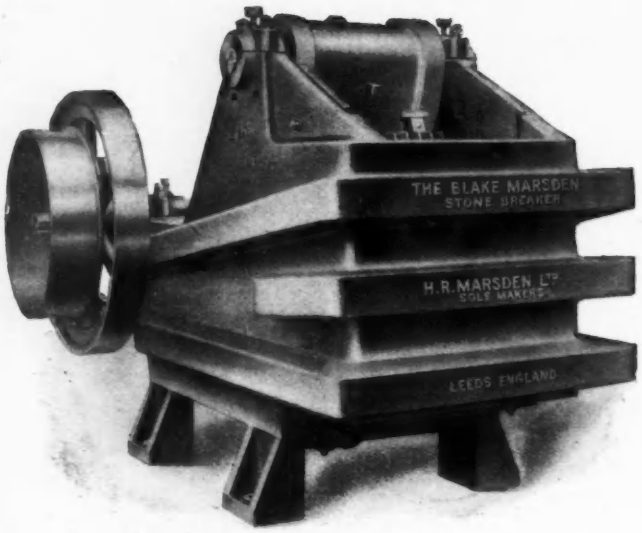

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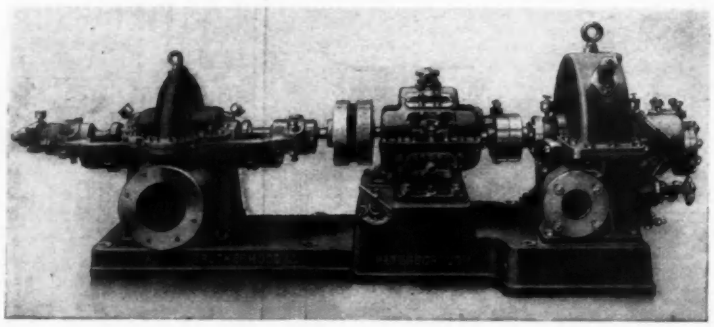

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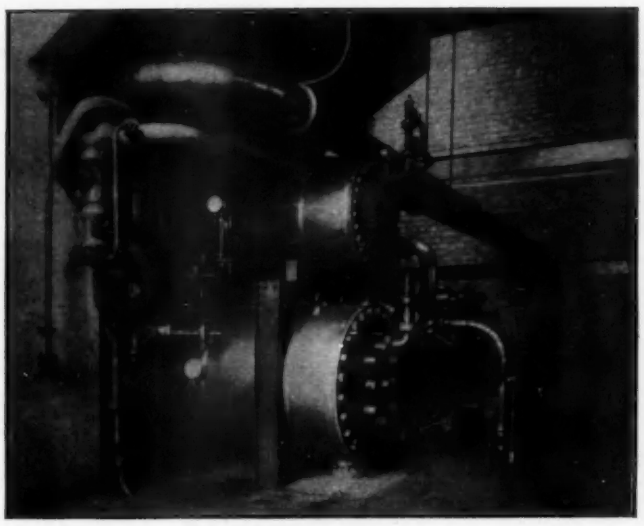

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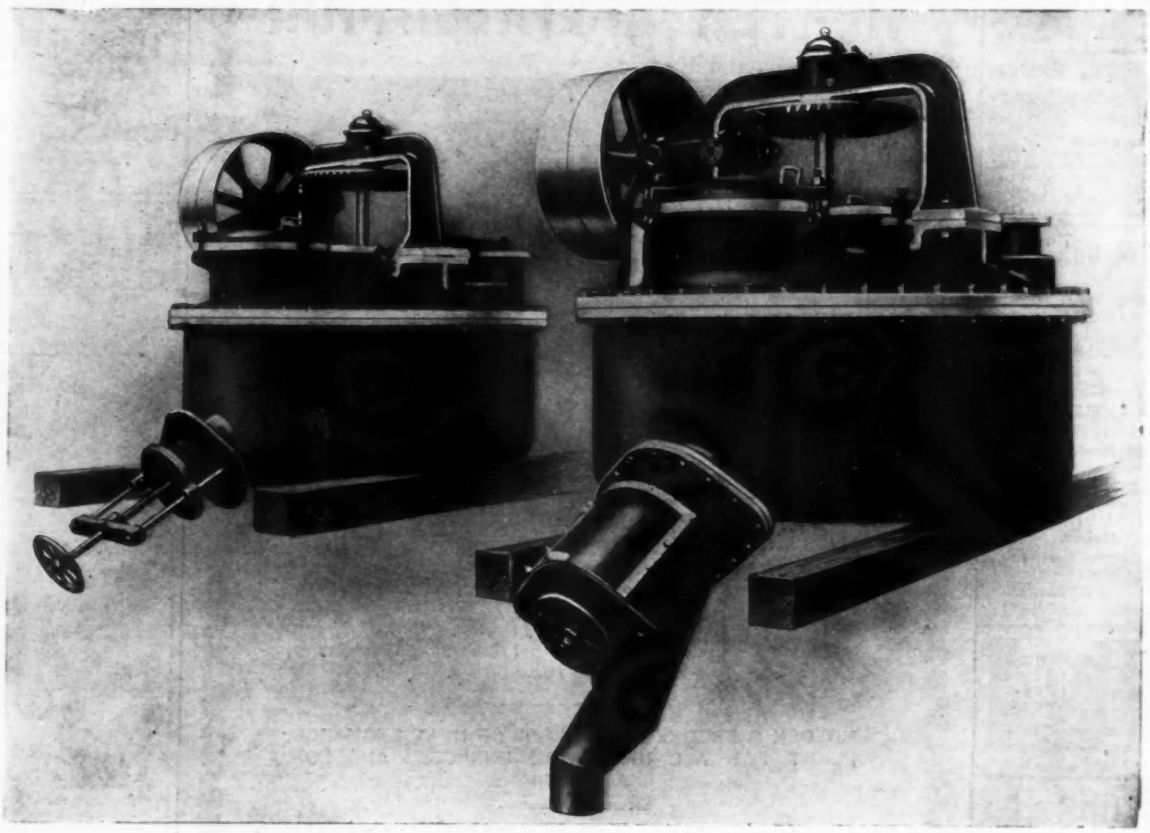

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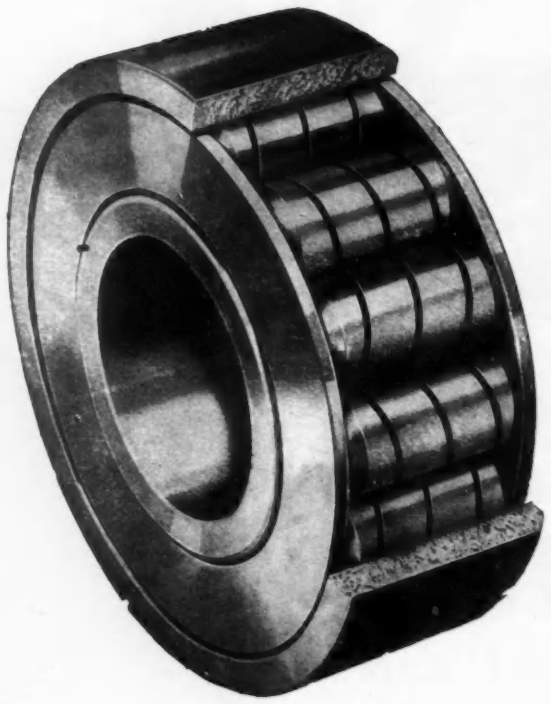

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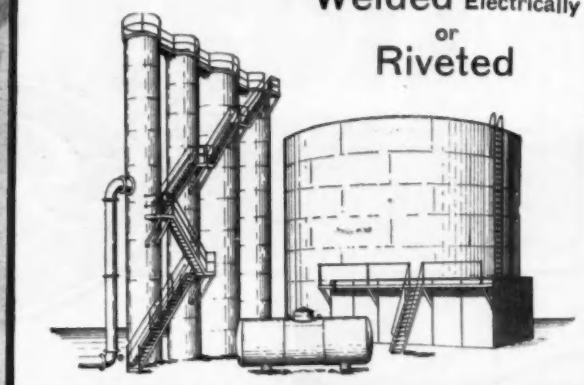

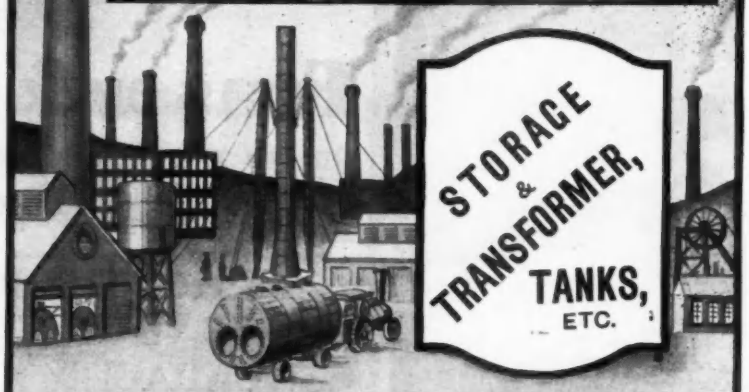

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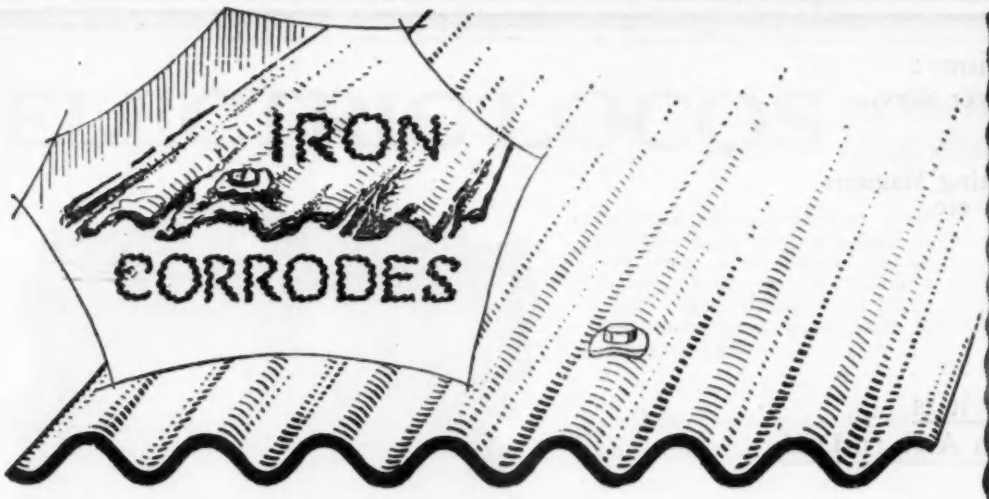

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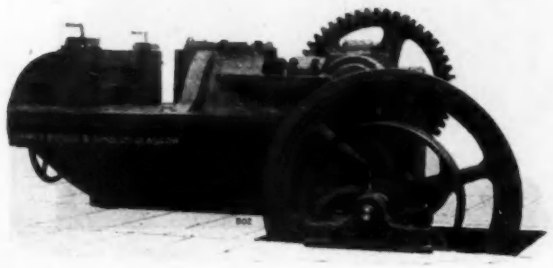

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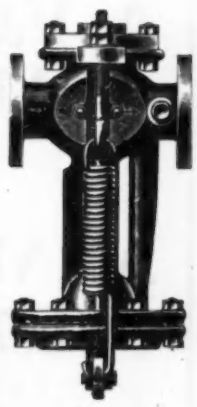

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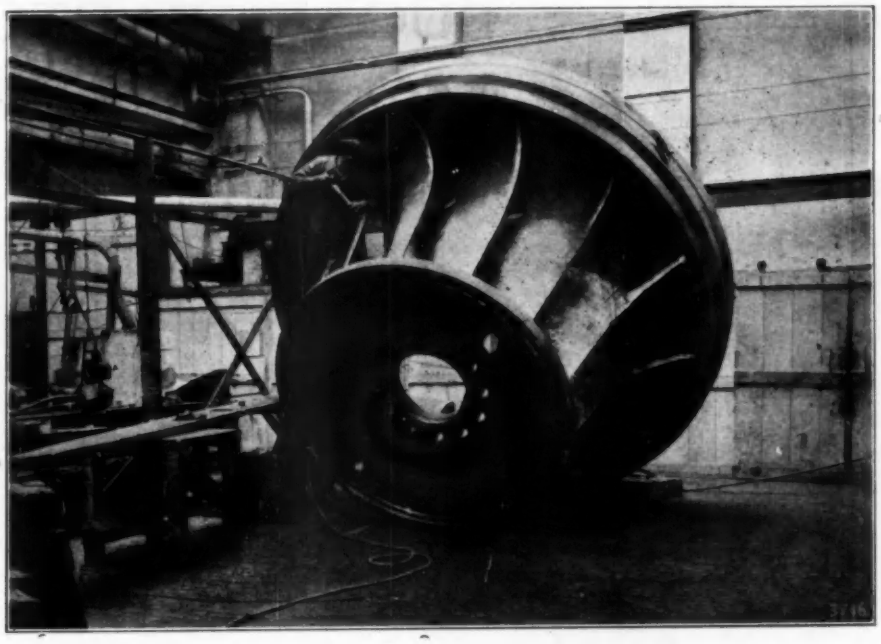

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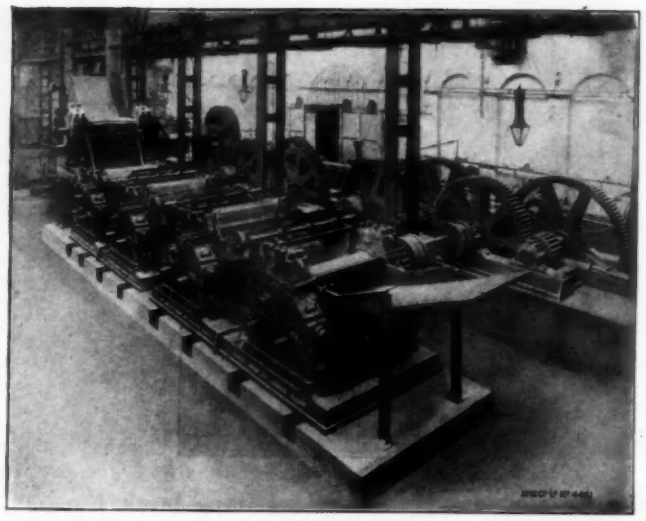

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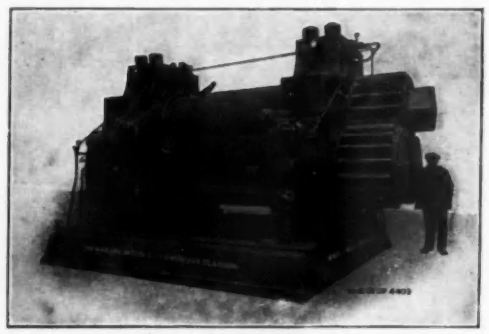

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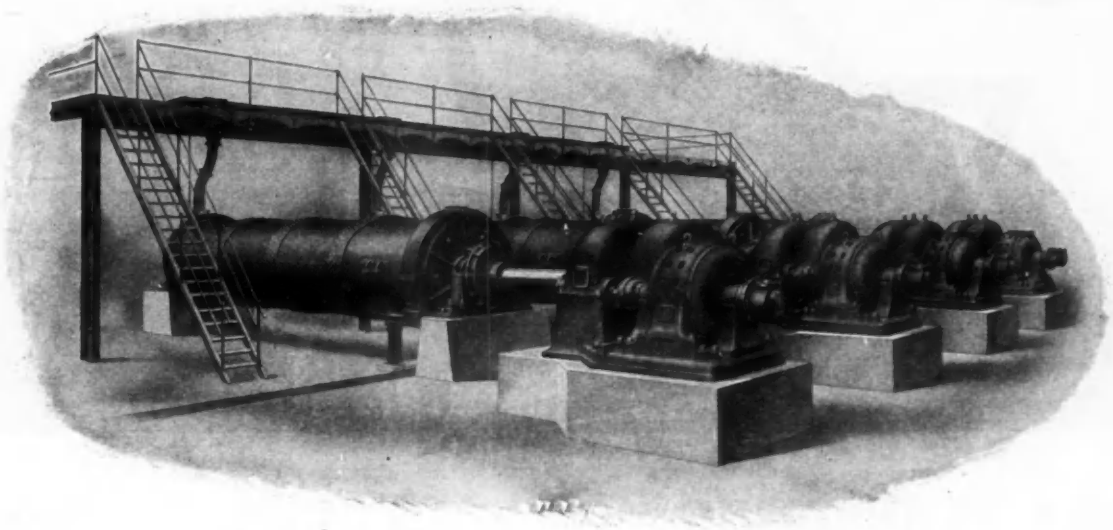

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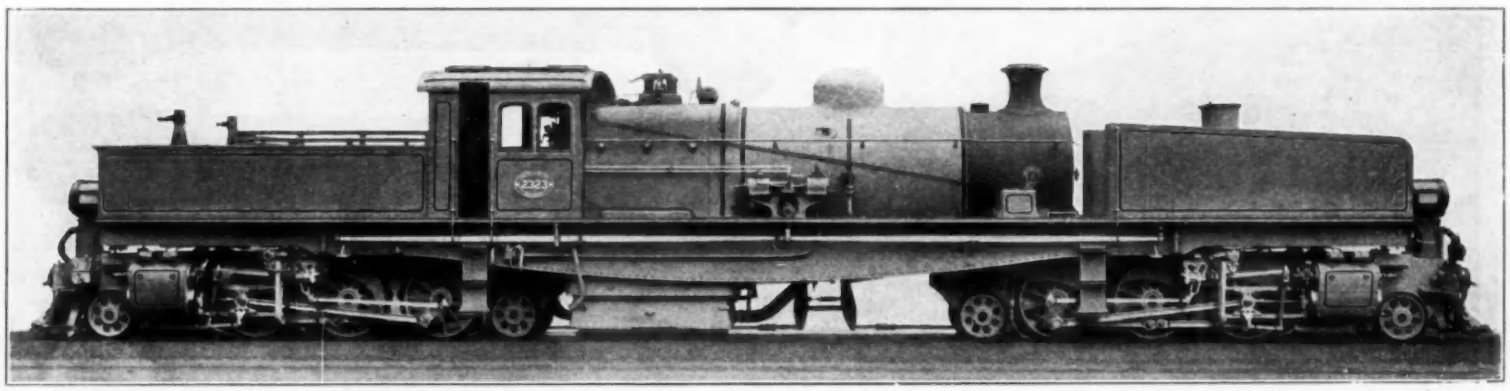

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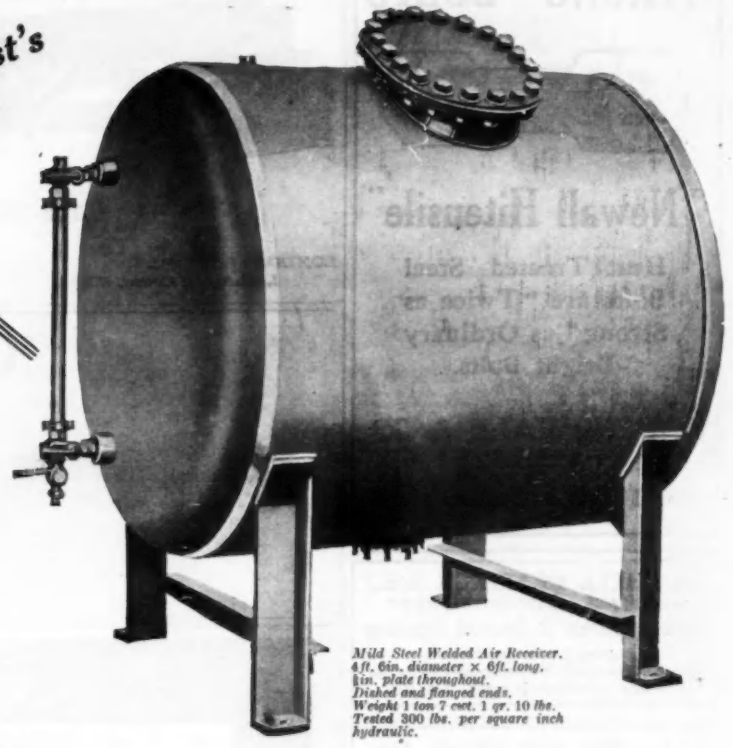

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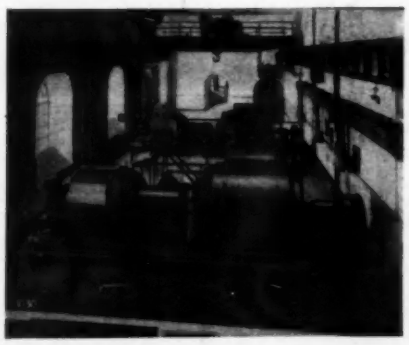

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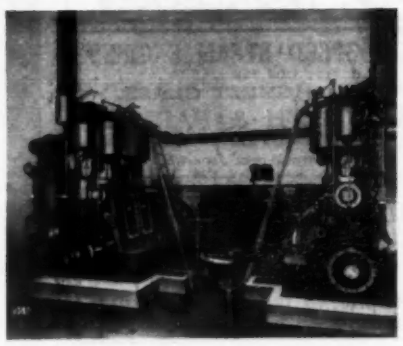

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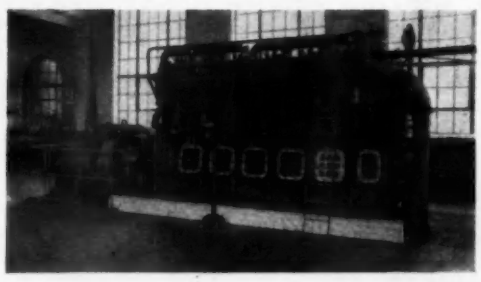

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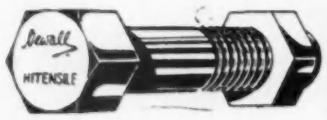

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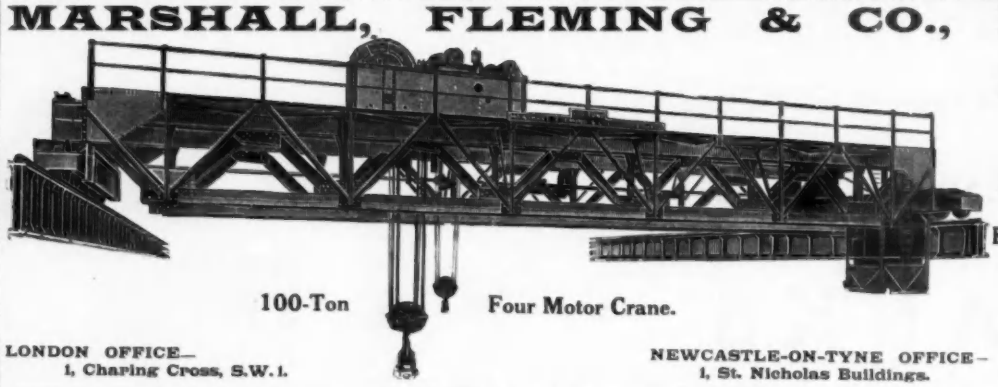

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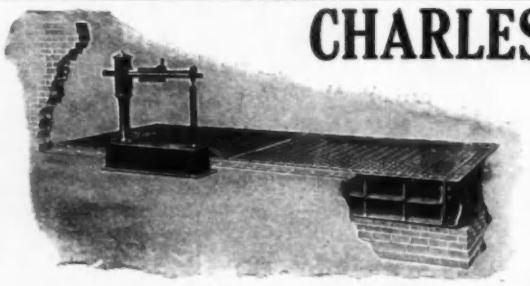

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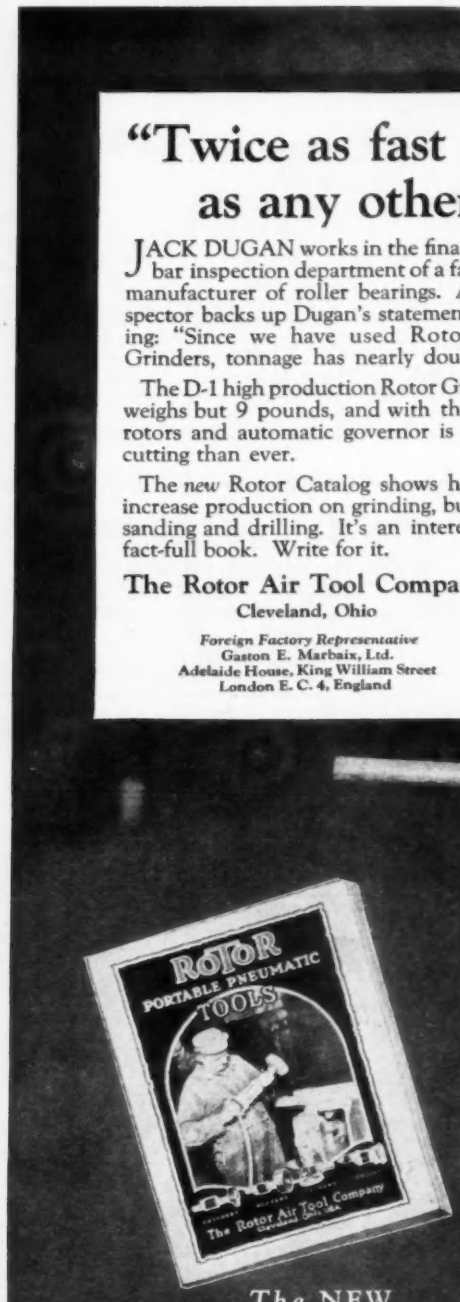

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The Leader in the Fittings Class—the one union that won't corrode on the line and have to be chiselled off, because the Forged Steel to Forged Bronze Thread connection and ball joint simply ***can't*** corrode. A simple turn of a wrench on the ring does the trick.

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Recommended for lines of vibration or sudden changes in temperature.

⅛" to 2"—Working Steam pressure 400 lbs.
Cold oil, water or gas (non-shock) 2000 lbs.

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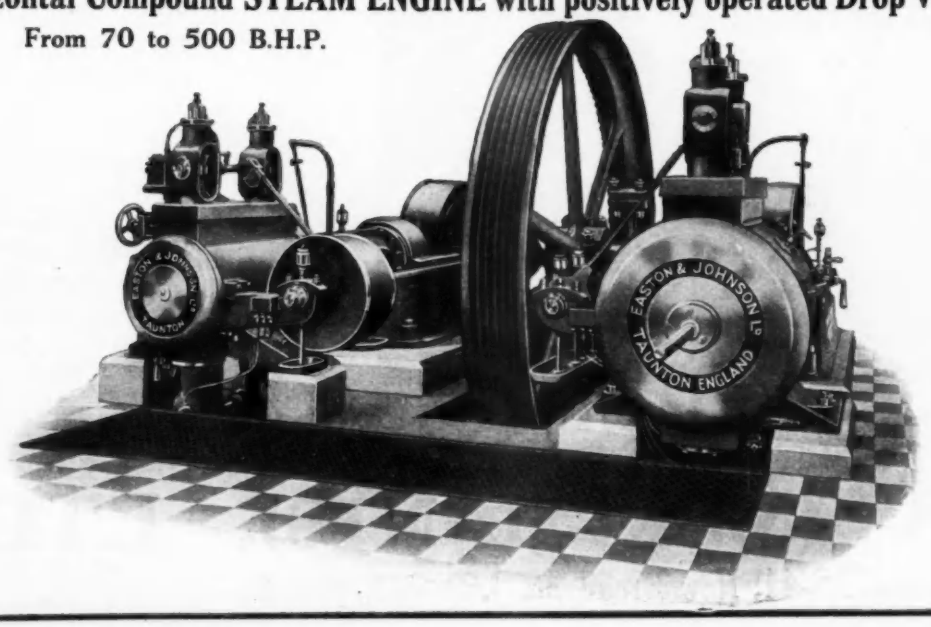

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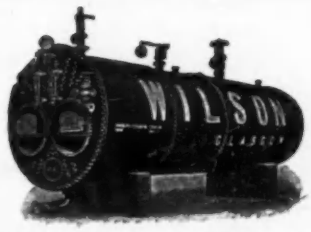

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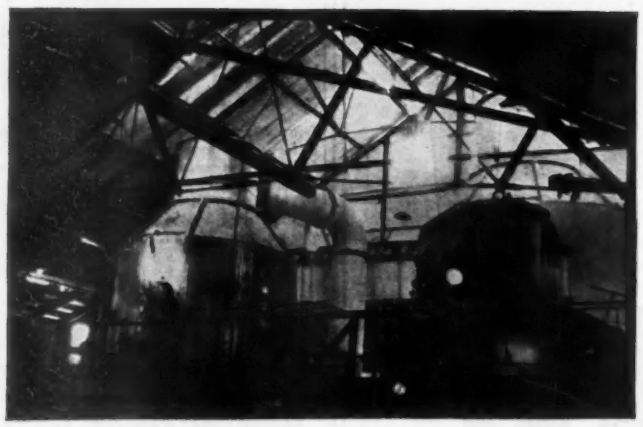

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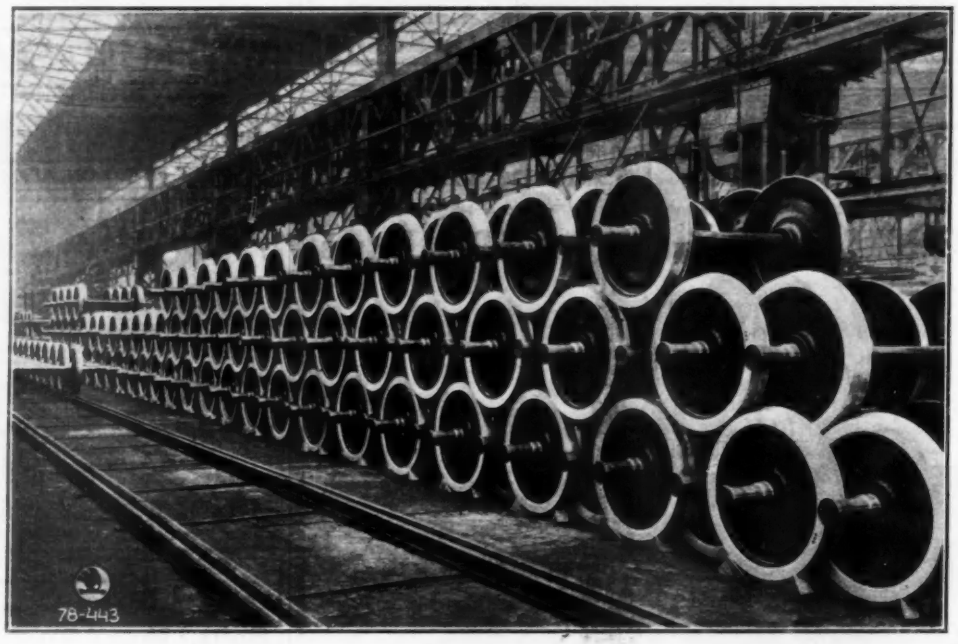

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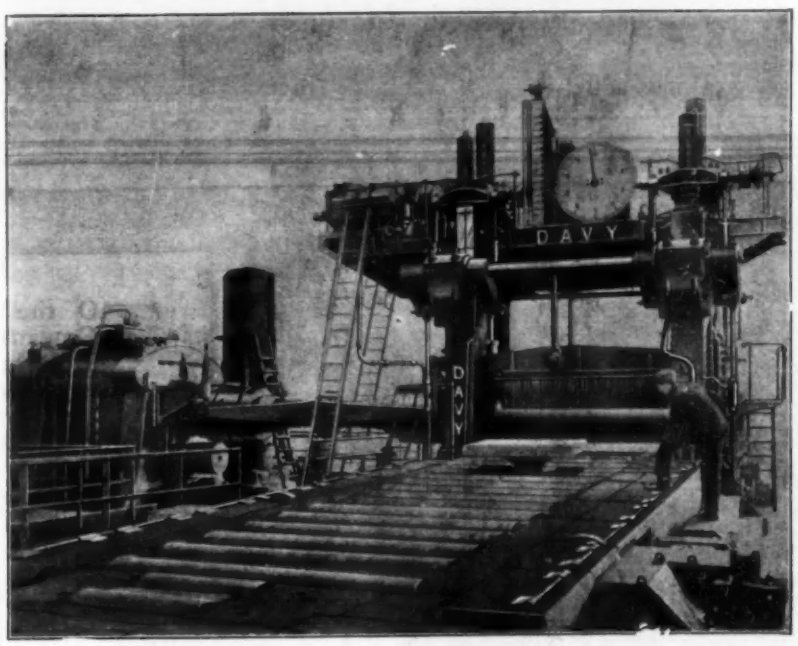

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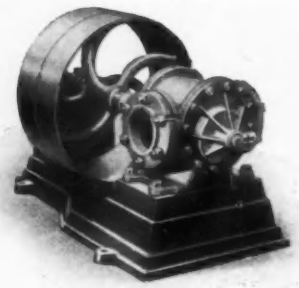

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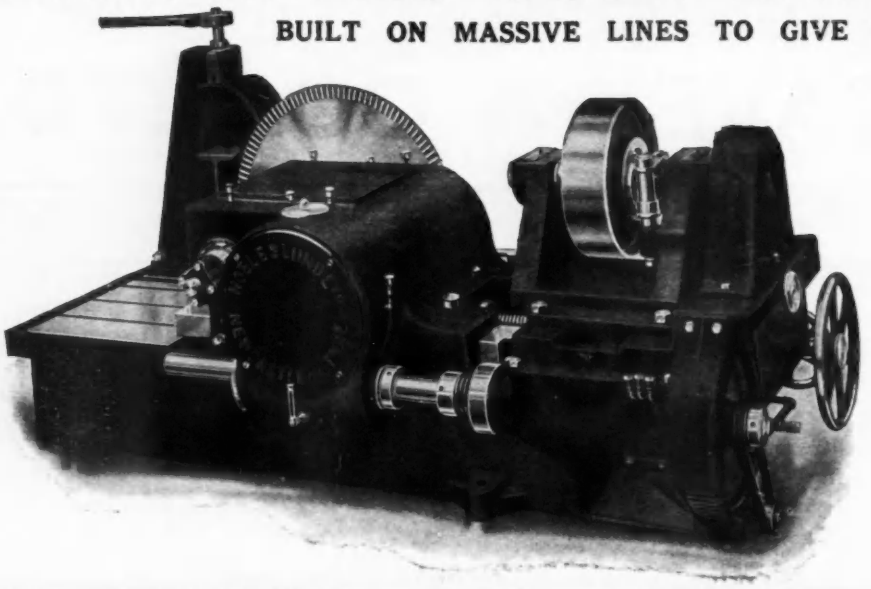

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6" "	"	1 "	30 "

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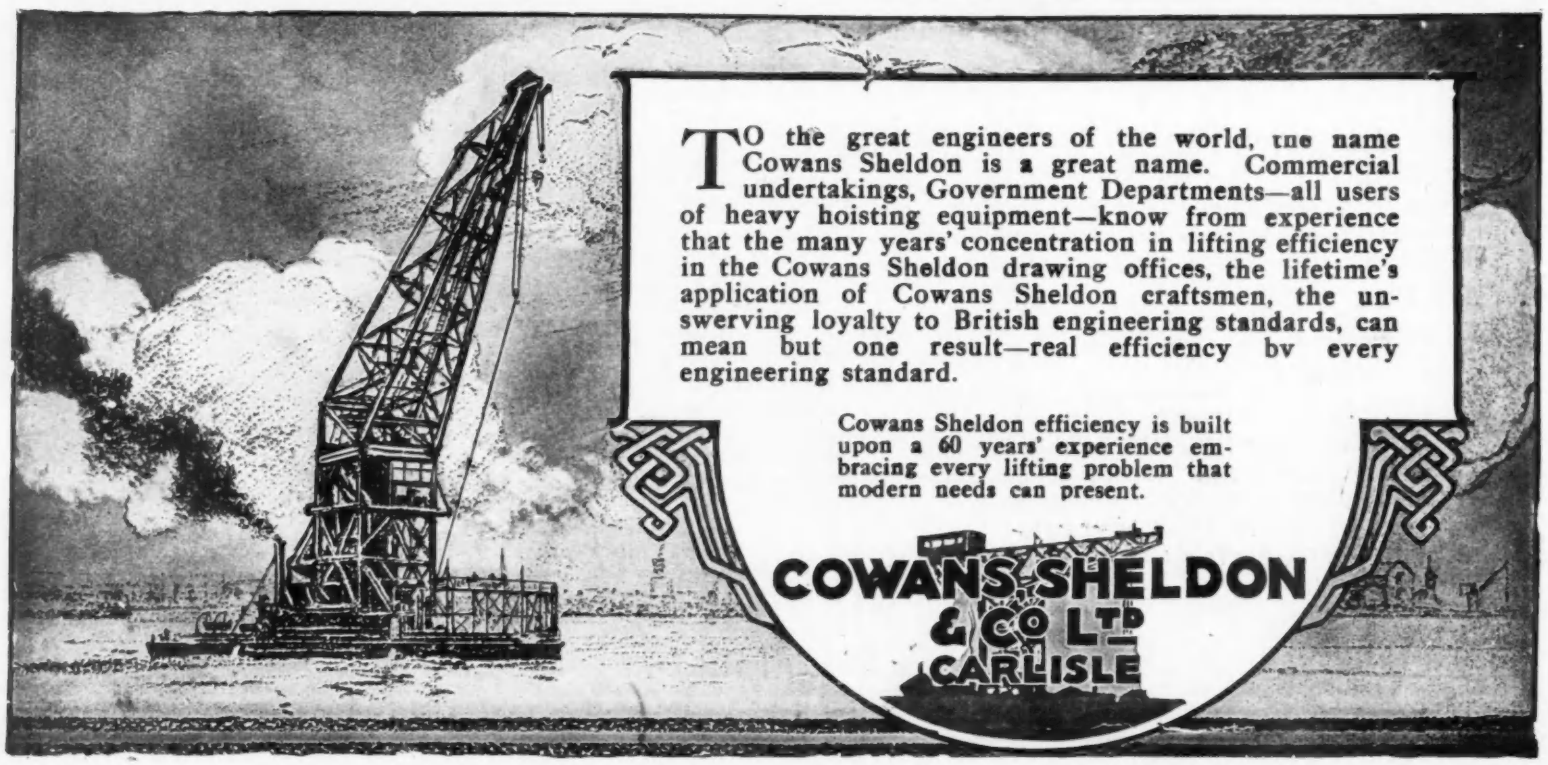
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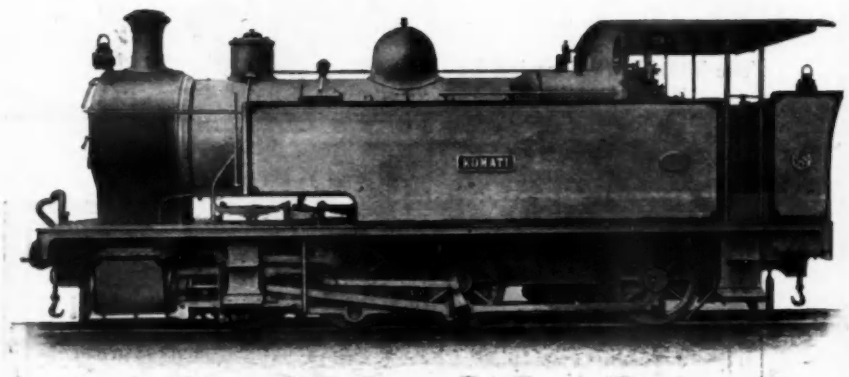

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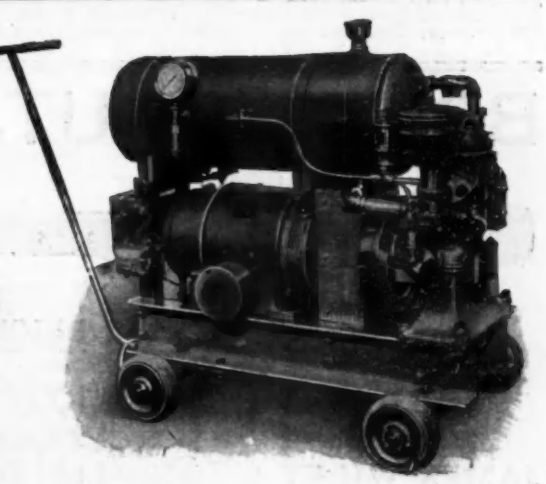

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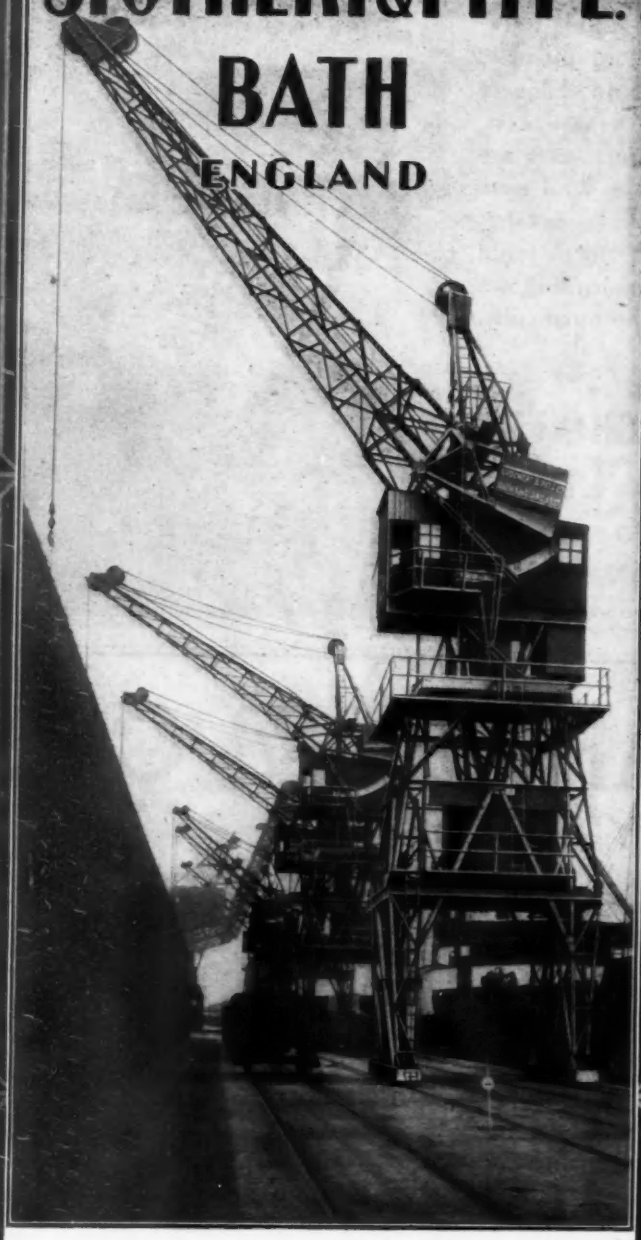

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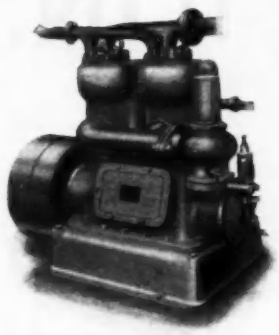

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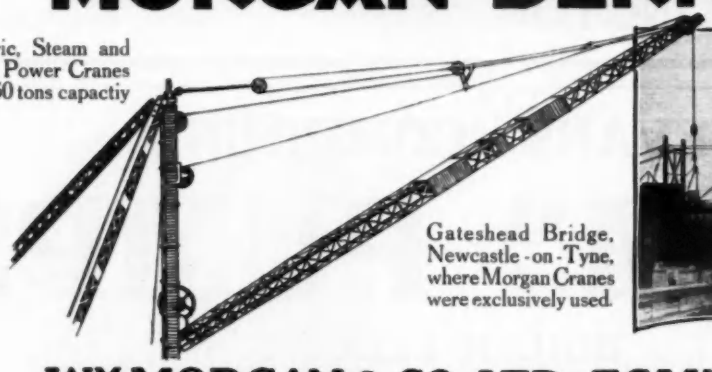

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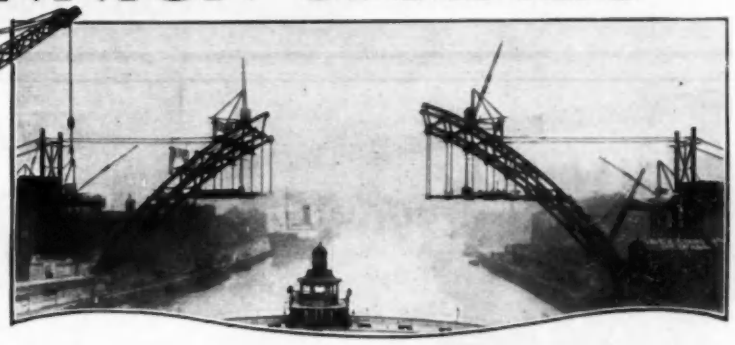

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Howell's cold-drawn weldless STEEL BOILER TUBES give the maximum resistance to corrosion.
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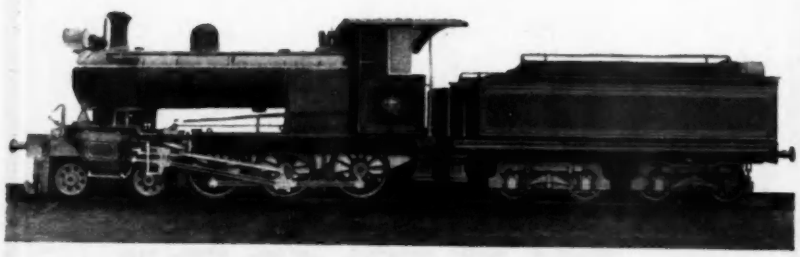

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Vertical Type High-Speed Cold Saw

The improvement in design promotes easy handling and reduction in setting up time.

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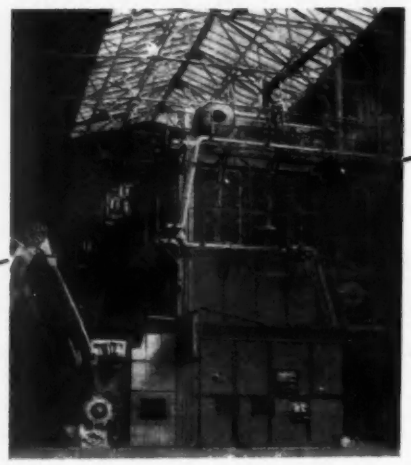

ILLUSTRATION shows two 50,000 lbs. Vickers Header Type Steel Cased Boilers in operation at Sunderland Power Station.

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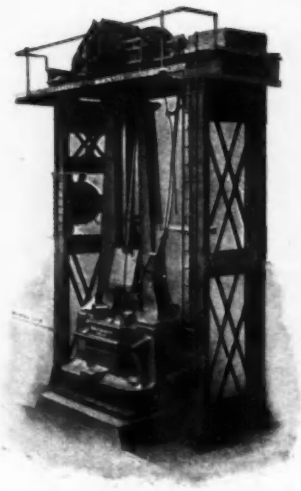

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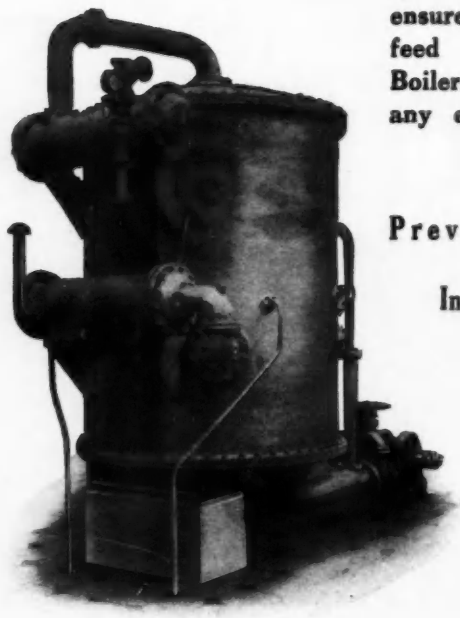

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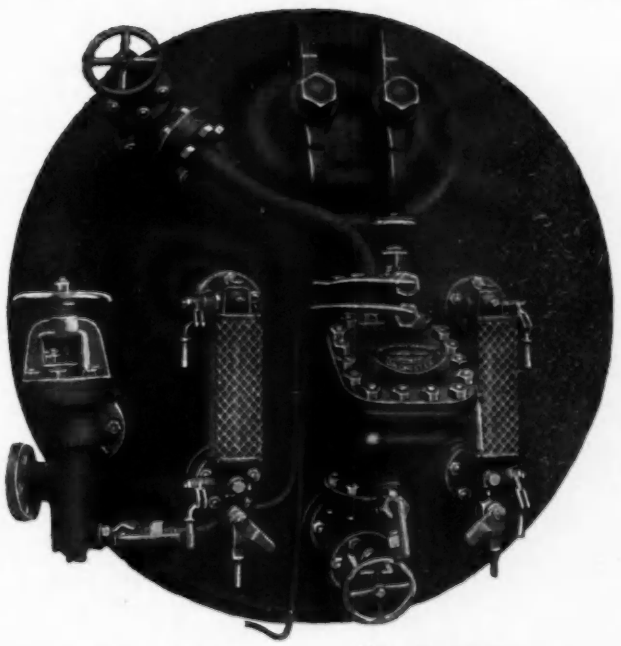

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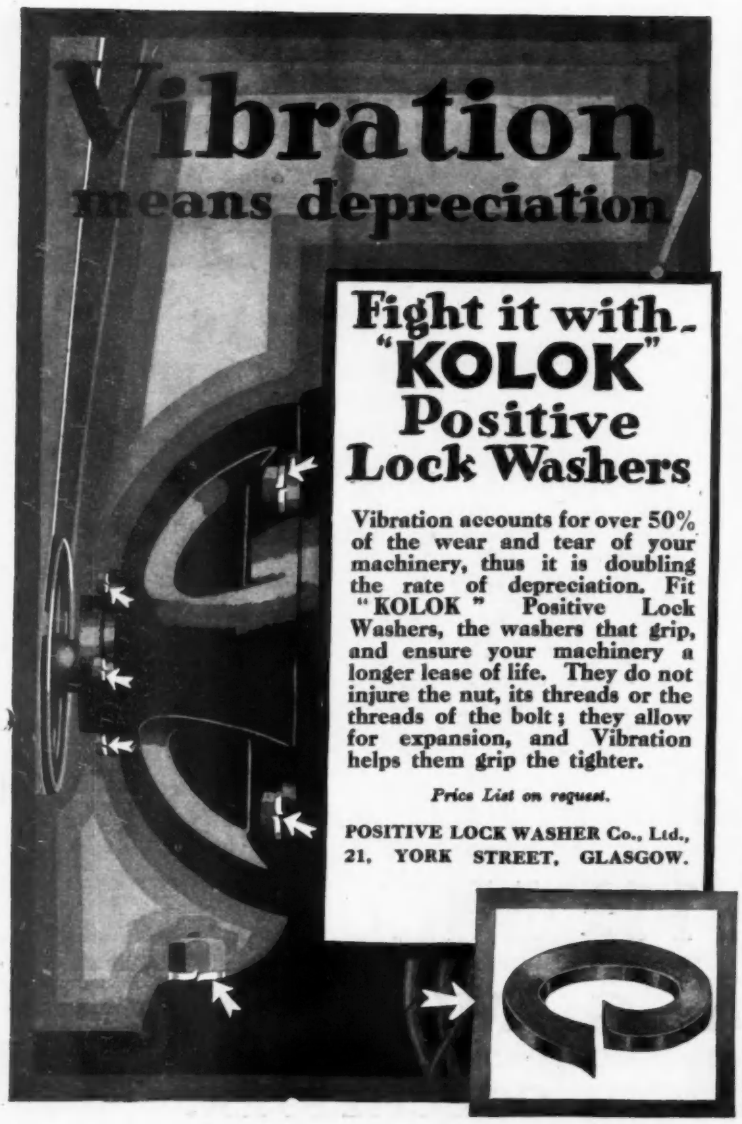

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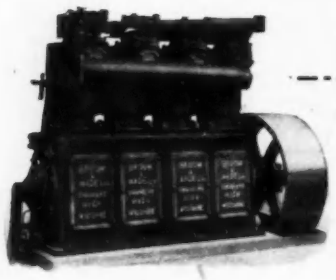

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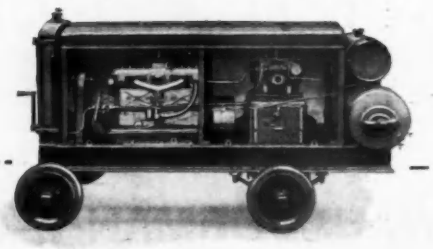

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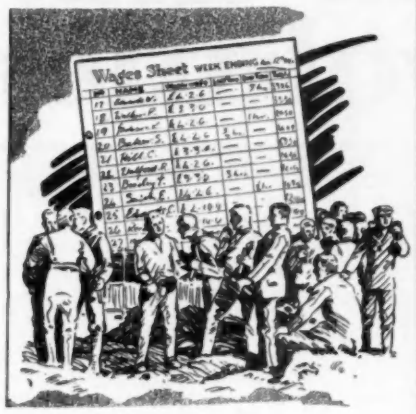

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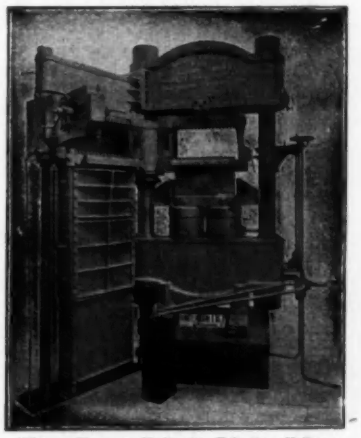

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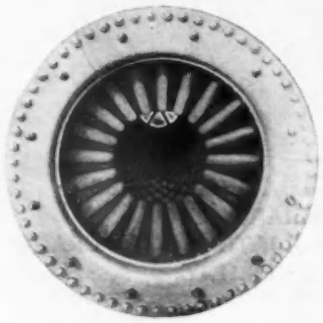

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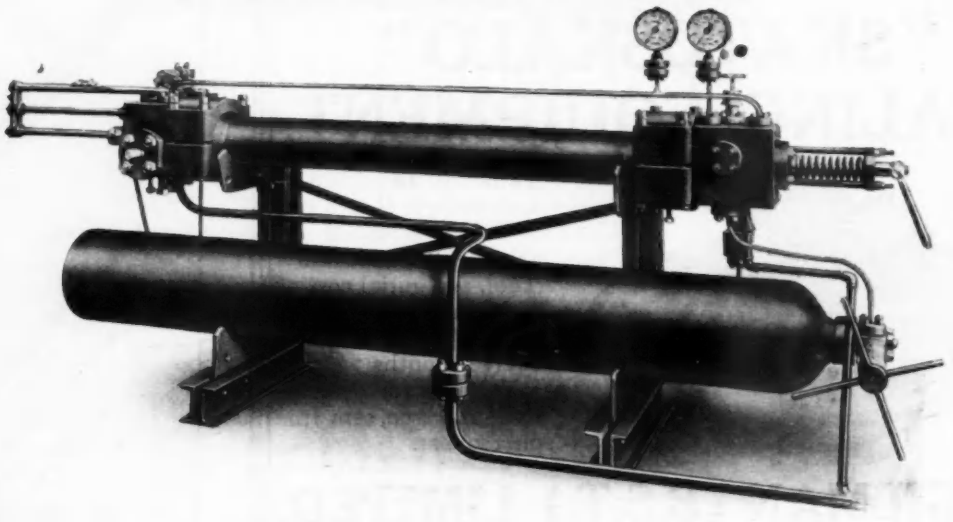

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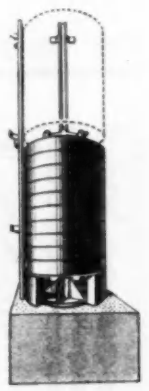

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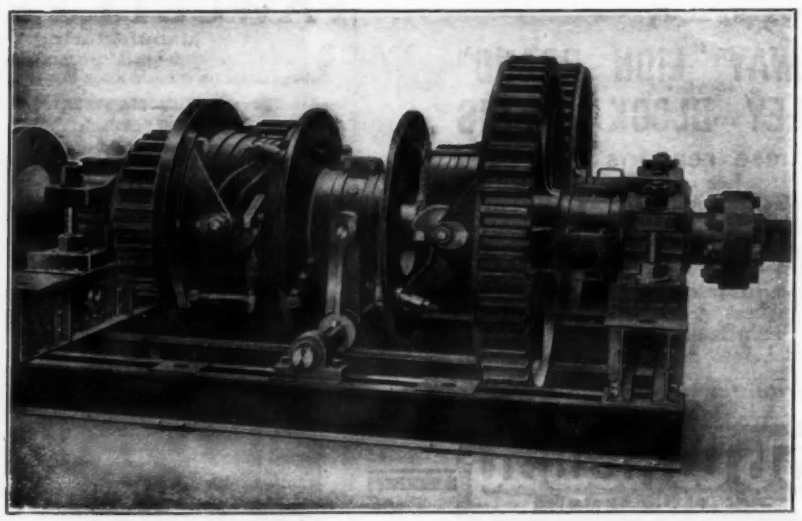

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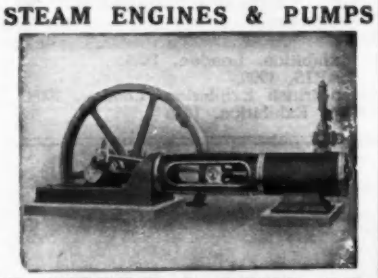

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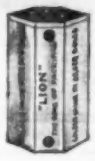

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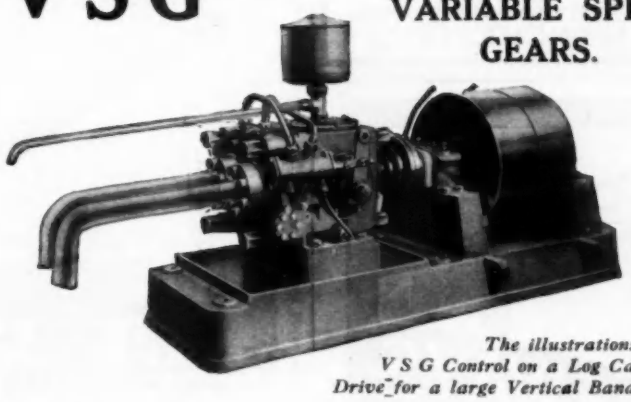

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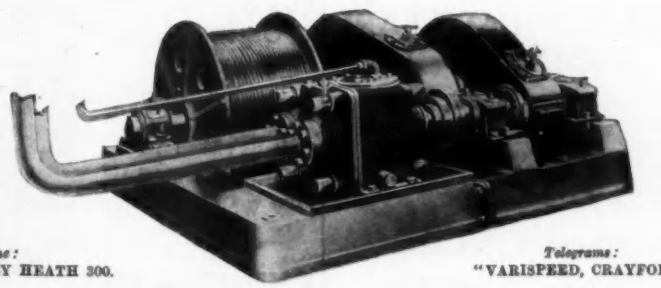

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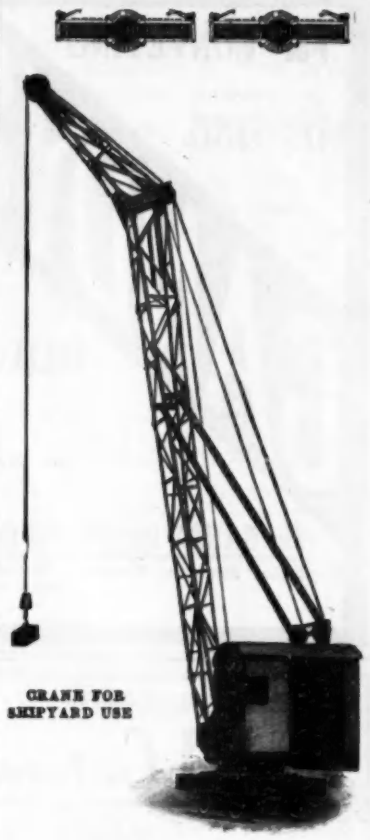

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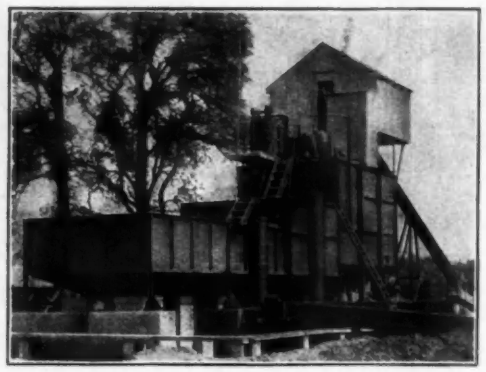

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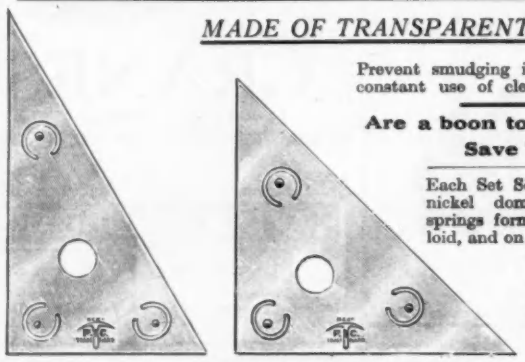

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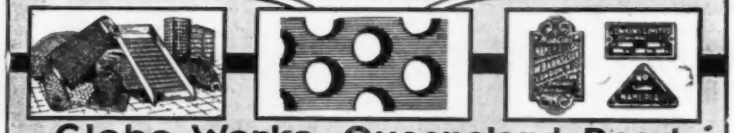

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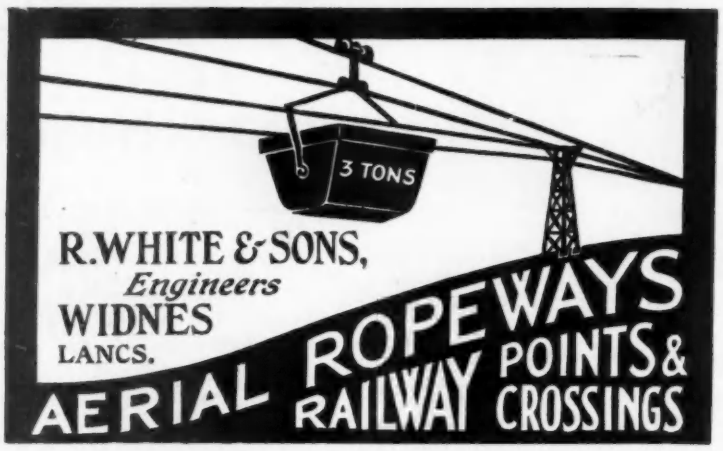
SILVER MEDAL, Inventions Exhibition, London, 1885.
GOLD MEDAL, PARIS, 1900.
GRAND PRIX & GOLD MEDAL, Franco-British Exhibition, London, 1908.
GRAND PRIX, Buenos Aires Exhibition, 1910



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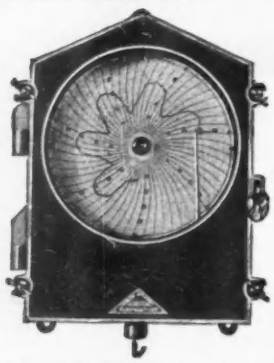

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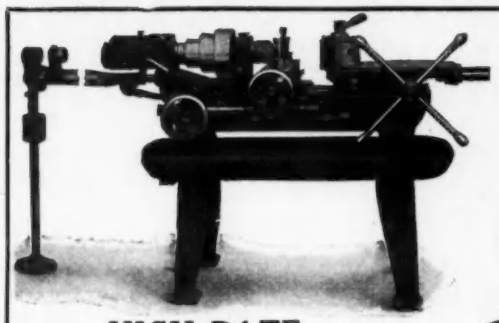

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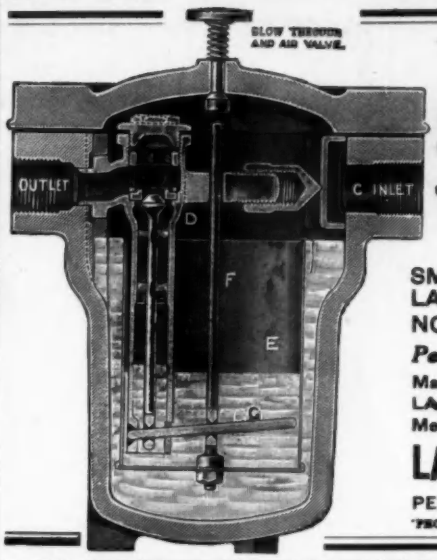

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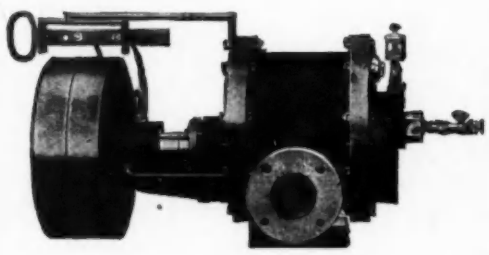

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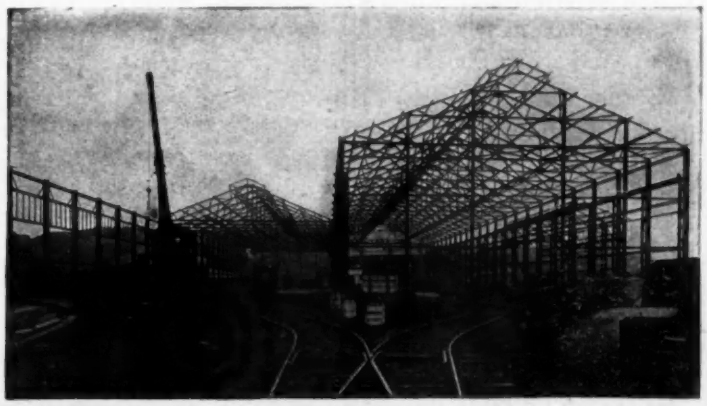

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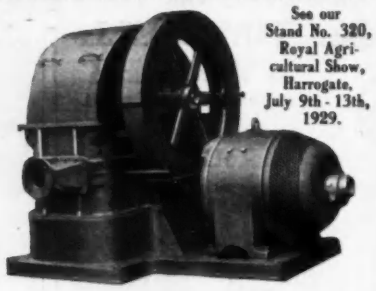

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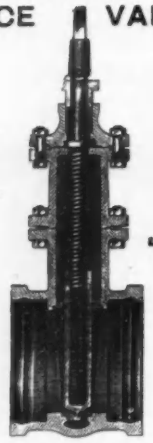

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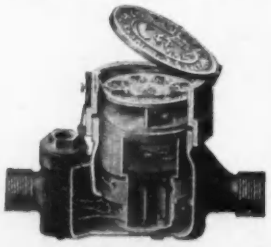

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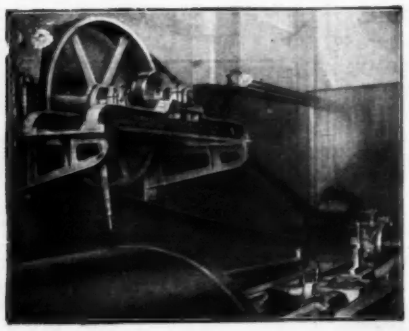

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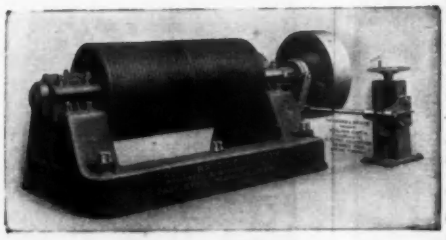

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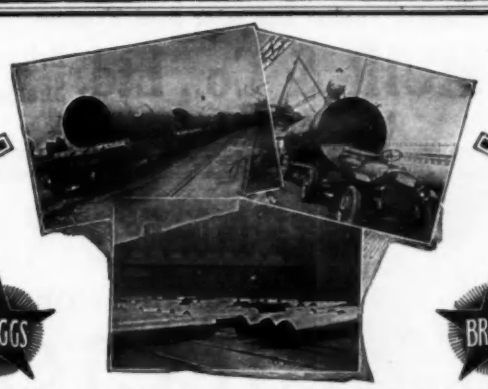

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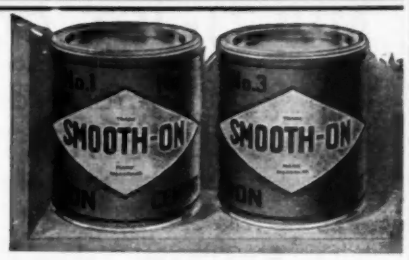

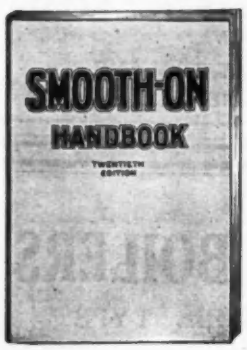

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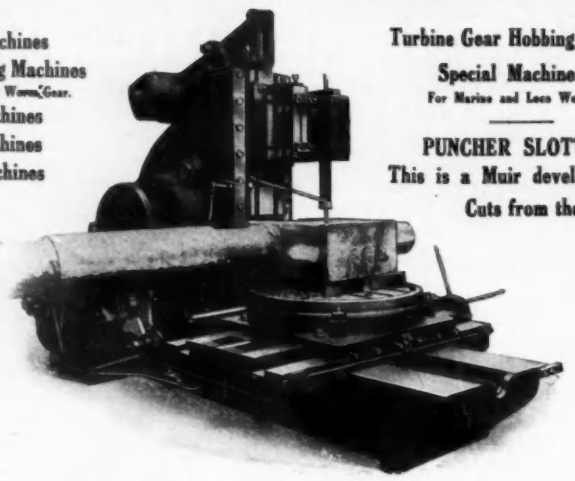

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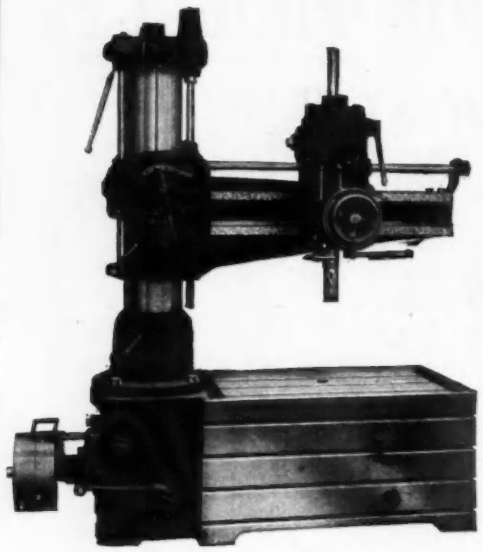

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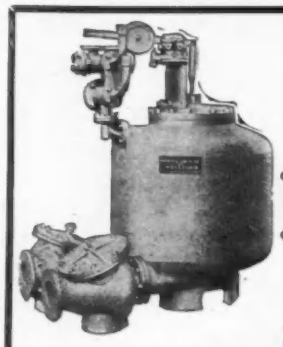

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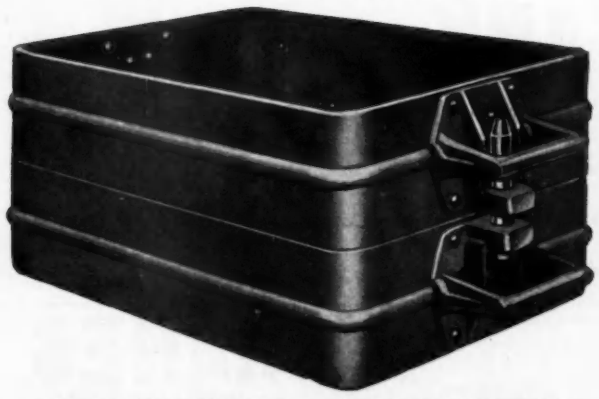

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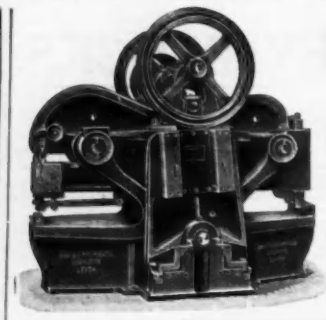

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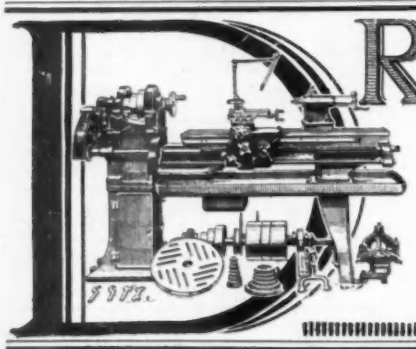
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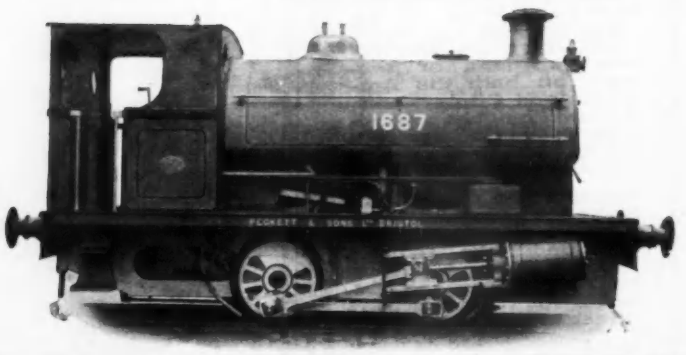

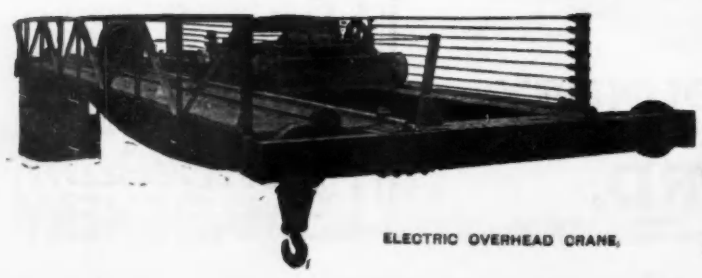
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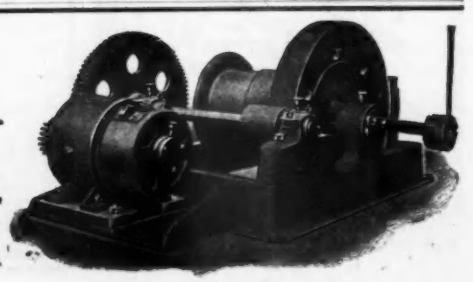
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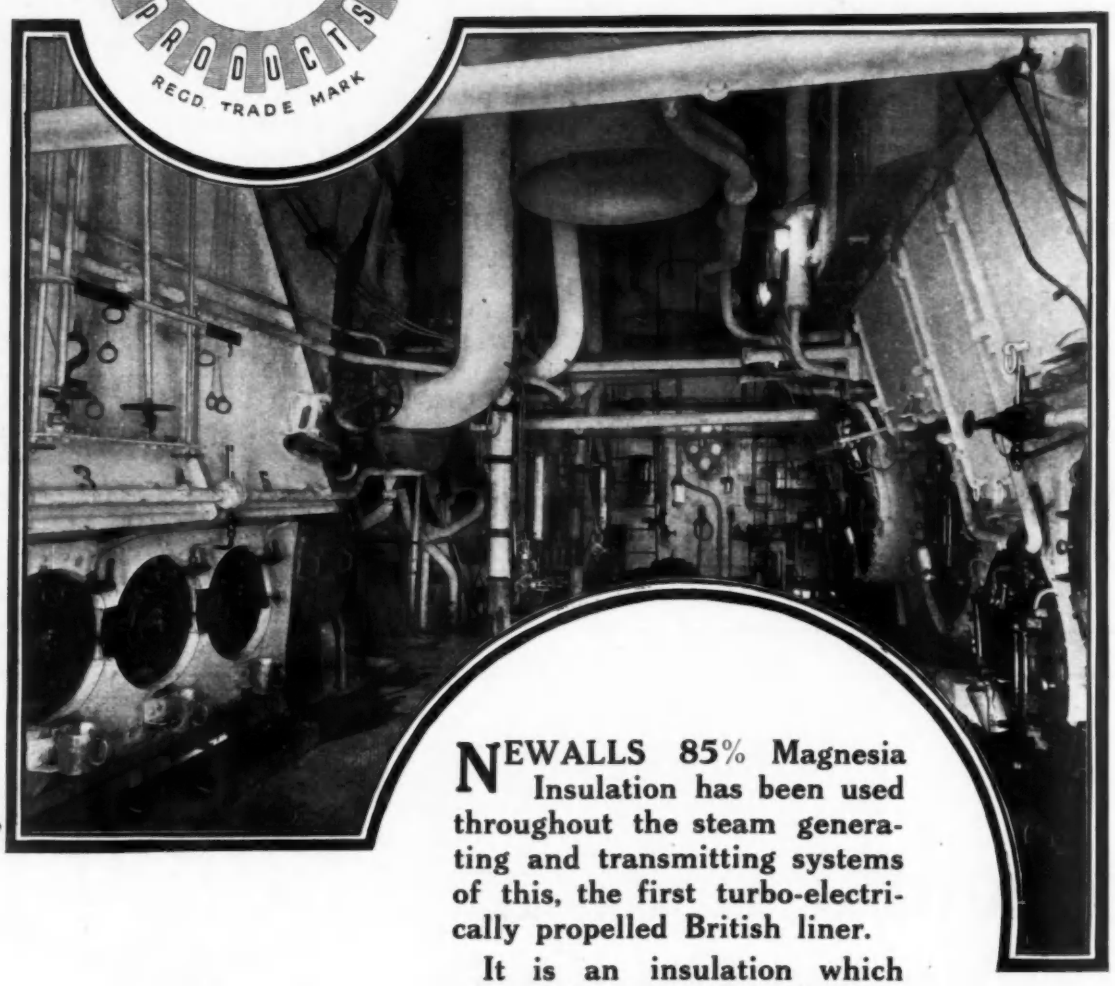

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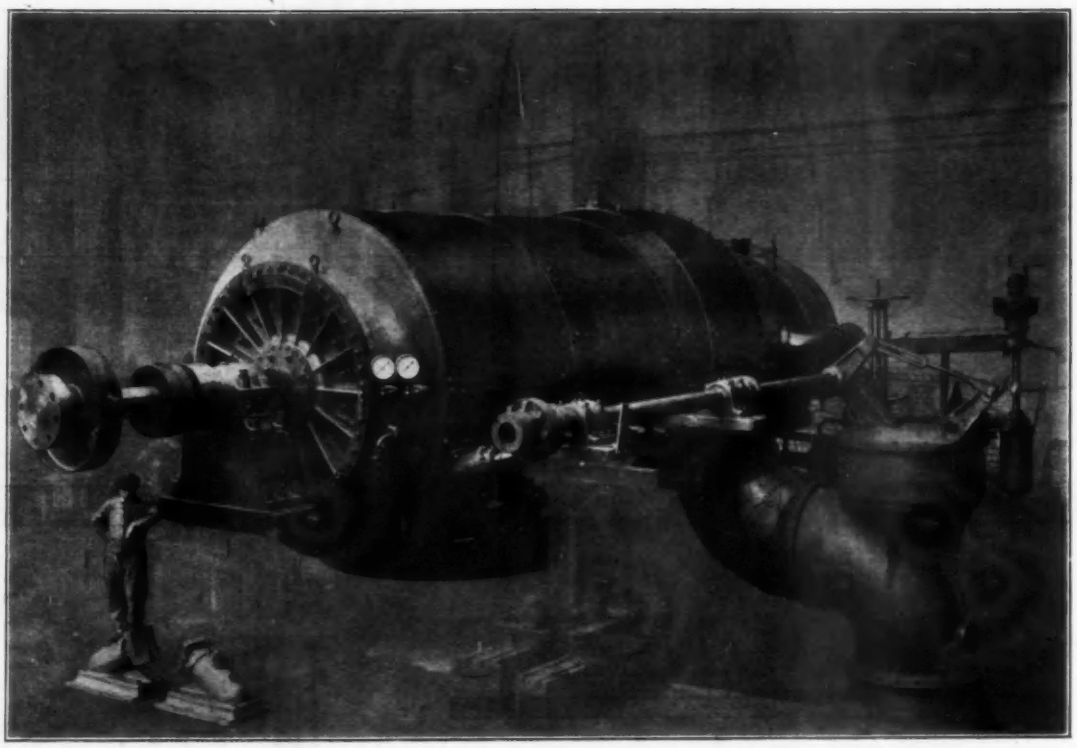

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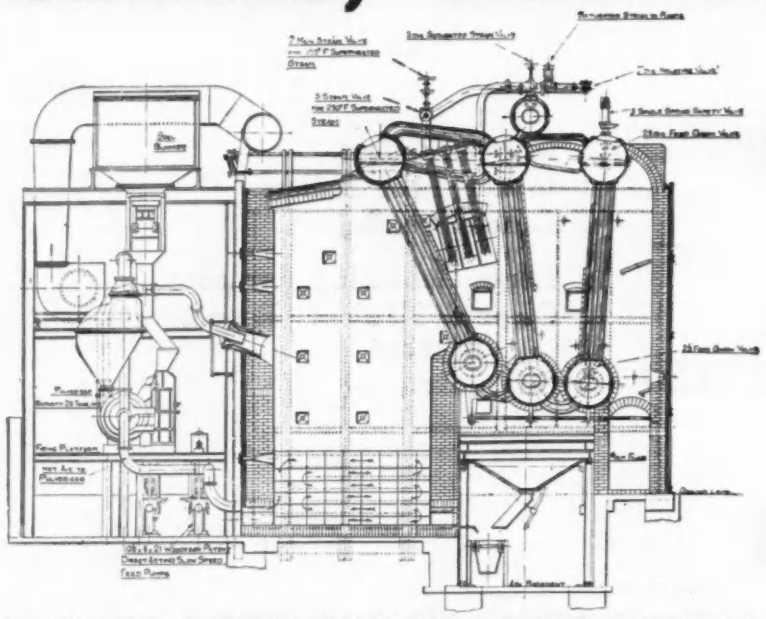

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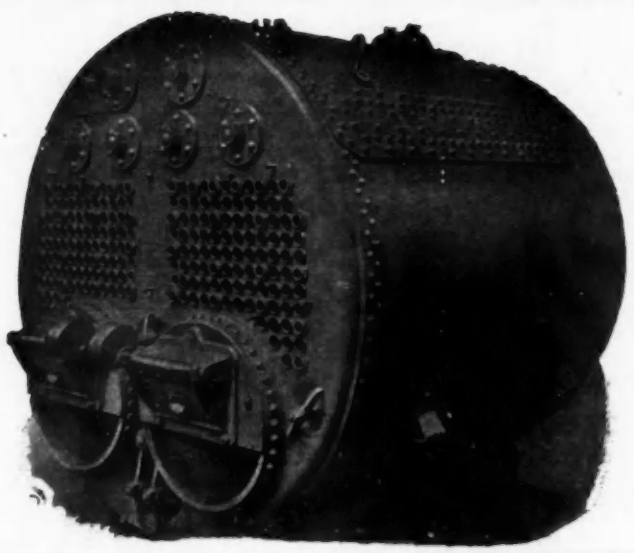

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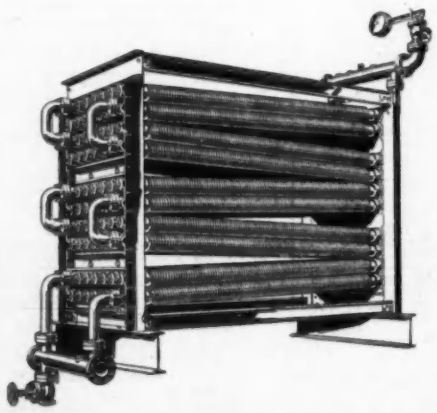

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